LAND MATTERS
Taking Stock and Looking Ahead

Selected experiences in memory of Rafael Crecente

UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

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Editor
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2021
UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

Deseño e maquetación
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Edita
Servizo de Publicacions
Campus Vida
15782 Santiago de Compostela
usc.gal/publicacions

DOI: https://dx.doi.org/10.15304/op.2022.1397

Photo courtesy of Lola Álvarez Centeno

Rafael Crecente Maseda
(1964-2015)
In memoriam

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Prologue

This book is a tribute to the late Rafael Crecente Maseda, to the person he was and the legacy he left behind in territory and land management. One of the great land management experts in Galicia, he was an Associate Professor at the University of Santiago de Compostela (USC) and founder and director of the Land Laboratory (LaboraTe).

Rafael Crecente's life and work centered around an active and inclusive approach to land. "What should we do with the land we have?" was one of his eternal questions and "Wars come and go, land always remains," one of his most well-known epilogues.

At the USC, he promoted and coordinated the Territorial Information System (SIT), the *Master in Sustainable Territory and Land Management* (Masterterra) and the PhD with the same name. He also actively participated as a researcher in South American countries, fundamentally Ecuador where he spearheaded a collaboration program. In Central and Eastern Europe he worked with the regional office of the Food and Agriculture Organization of the United Nations (FAO) in Budapest. He was also a guest lecturer at the University of Munich, a visiting scholar at the University of Wisconsin-Madison and researcher at the Institute of Agrarian Biodiversity and Rural Development (IBADER) attached to the USC Territory-Biodiversity Research Group.

Throughout his career, Rafael Crecente enthusiastically explored the multiple facets of land management and liked to explain it to his students using one of his favorite quotes: "It is at the same time a scientific discipline, an administrative technique and a policy developed as an interdisciplinary and comprehensive approach directed towards balanced regional development and the physical organization of space according to an overall strategy."[1]

1. Definition of "Land Management" from the 1983 European Regional/Spatial Planning Charter (Torremolinos Charter)

Inspired by this multi-faceted approach, he pioneered the analysis of land in Galicia from different perspectives, reflecting on the multiple dimensions of the concepts of territory and "lands" in plural. Rafael Crecente was interested in land as much as a subject of study and knowledge, with its biophysical, institutional, social, economic and spatial realities as of one of action and management. He faced its challenges and conflicts with passion, promoting the technological and institutional innovation necessary for sustainability and extolling coordination and agreement as a guideline for land construction.

From the LaboraTe, Rafael Crecente promoted his holistic vision and transdisciplinary perspective of the study of land and innovation. "In nature, hybrid species are usually sterile, but in science the reverse is often true. Hybrid subjects are often astonishingly fertile, whereas if a scientific discipline remains too pure it usually wilts."[2] This quote from Francis Crick, one of the discoverers of DNA, was the one he chose to head the LaboraTe website. For "Rafa", as his friends and colleagues knew him, it summarized his way of understanding research. Or better still, research-action which was something he tried to implement in the countless projects in which he participated. This approach appeared in multiple forms and permeated all his initiatives.

The extensive, diverse web of collaborators, be they geographical or inter-disciplinary, which Rafa wove throughout his life have borne the fruit and provided the means to create this book. A network which enrichened his vision, fed his mission and facilitated the construction of a hands-on land management community, blending interest and responsibility for the local and global. "One people-one planet - there are no frontiers," Rafa often said. "We all share the same air, climate, atmosphere. This is the Planetary Challenge!"

It was one of these colleagues who sowed the first seed for this collaborative work. What better way to remember Rafa than by collecting work from experts who shared an interest in observing, questioning and tackling the main current and future challenges facing territory?

Contributors were all given one brief: "To summarize, in a few pages, the most valuable knowledge you have gathered along your academic careers. The land management wisdom you would like to transfer to future generations."

Essentially, it would gather the main elements which characterized his work. The focus would be multi-disciplinary and inclusive and would aim to collate a record of experiences and knowledge. These, in their sum, would offer the

2. Francis Crick, 1988, 'What Mad Pursuit' reader a valuable and eclectic vision of land and the approaches to its study in all its environmental, social and economic dimensions.

The way in which each author has achieved this, as well as the actual object of study (territory and its *lands*), is diverse. The essays take place in different spatiotemporal scales, come from a variety of disciplines and methodological approaches and bring together multiple traditions and land management paradigms.

We began this prologue by saying that this book paid homage to Rafael Crecente Maseda and this is without doubt its chief motivation. But this is not the major incentive for the reader. If it were to have a principal objective, it is that the collected works condense the experience, in different forms and formats, of an international community of planners, both academics and practitioners. Their observations and messages will no doubt contribute to meeting the land challenges we have before us both individually and collectively.

Climate change, loss of biodiversity, depletion and deterioration of natural and energy resources, inequality and social exclusion, among others, are inescapable challenges. All these have a systematic character which makes them complex and in need of a transdisciplinary and inclusive approach. The same one which inspired the origins of this book. They remind us of our inseparable belonging to and interaction *with* a globalized biotic system on which we depend and with which we act on perhaps aggressively and irresponsibly. Because just as Rafael Crecente liked to quote: "There are sufficient resources on this planet to answer the needs of all, but not enough to satisfy everyone's greed." (Ghandi).

In all, there are 13 essays from seven countries and three continents. These contributions are organized into three sections: *Land Policies, Culture and Institutional Design - Land Management Instruments - Enabling Technologies in Spatial Planning: from Theory to Practice*.

The first section gathers observations about the nature of land management, focusing on the social and institutional dimensions, frequently overlooked due to biophysical or economic issues. This section, and the book itself, could not have a more enriching introductory chapter. In it, Prof. Harvey M. Jacobs capitalizes on his fruitful and prolific academic and professional experience. Harvey M. Jacobs was a Professor at the University of Wisconsin-Madison USA for 34 years (1984-2018) and at Radboud University Nijmegen, The Netherlands (2012-2019). He is now Emeritus. His specialty is the social and legal aspects of land policy, focusing on property rights and structures (like zoning) that communities and societies develop to manage the relationships among different property rights. Despite his busy workload Prof. Jacobs passionately engaged with Rafael Crecente, helping to develop some of his most loved projects, the Masterterra and related PhD program courses.

In this chapter, he reflects on how his research revolves around the argument that land policy is fundamentally social in nature. If this is true, then there are never 'right' and 'wrong' answers to the question - What should land policy be? - only negotiated answers. Thus Prof. Jacobs argues that a key role for professional land managers is to help a complex "multilogue", (it is always much more than a dialogue), progress towards what will always be a temporary resolution in an ongoing discussion.

The second chapter has been provided by Terry van Dijk, who is an Associate Professor and lectures at the University of Groningen on regional design practices in the Netherlands. In his contribution Ass Prof. Dijk discusses how small institutional settings can have large consequences for a landscape. Sprawling cities, forest fires, peripheral airport locations and the over-production of offices can be explained from institutional drivers. Land management, he argues, must address the root cause of land use patterns to prevent only the symptoms being treated. Rules, through people, affect land use and when the latter is problematic, the first may need to be reconsidered. The relationship between informal and formal institutions, especially property rights and land use dynamics was the core topic of FARLAND, an INTERREG project where Terry van Dijk and Rafael Crecente began a fruitful and long-lasting collaboration.

Nevertheless, as Jose María Tubío discusses in chapter three, the pair - land use/institutional set up - is a very complex matter. Understanding the actual nature of land use conflicts and their relation to eventual institutional failures requires an in-depth analysis. Jose María was a researcher at the LaboraTe group, expert in land institutions and lecturer at the *Masterterra*. Together with Rafael Crecente, he led the group's collaborative projects in South America, primarily Ecuador. There they both promoted several activities which helped to strengthen spatial planning and geospatial technologies within the national research and innovation ecosystem.

Chapter four is a contribution from Professor Holger Magel and Associate Professor Uchendu Eugene Chigbu. They argue for a universal regulation for development through comprehensive land management based on human rights and community dignity. Here the social dimension is analyzed not from a methodological or positive perspective, but instead positioned as the main goal. They point out that growing spatial inequalities and the increasing lack of cohesion in many countries calls for equal spatial planning and development that caters for the simultaneous (and to an extent, equal) evolution of both the urban and the rural areas. Therefore, territorial justice has in their view an ethical normative background. The chapter builds on the Bavarian experience of land management, which was also an inspiration for Rafael Crecente. He enjoyed the guidance of Prof. Magel, Prof. Emeritus of Excellence at the Technical University of Munich and founder of the International Master Program in Land Tenure and Land Management in urban and rural areas.

The first section of this book closes with chapter five, an inspiring look at the transformative approach of long-term oriented environmental [adaptive] management by Wim Timmermans and colleagues from Wageningen UR, (The Netherlands). The authors reflect on the potential of shifting from straightforward linear solutions to complex non-linear ones in water (and land) management. Also, from moving from an external observation perspective to that of a project leader within a real-life transition process. This is a new approach from Wim Timmermans, who since his first interaction with Rafa and the LaboraTe introduced the theoretical background of complexity and chaos in planning. This in turn helped to contribute to an integrated and enriched view of institutional change. His collaboration certainly pushed forward the innovative and transdisciplinary character of Rafael Crecente's work.

The second part of the book gathers five contributions on diverse *Land Management Instruments*. The first one is by Per Kåre Sky, currently Professor in Land Consolidation at the Norwegian University of Life Sciences and former Land Consolidation Appeal Judge for many years and his colleague Helén Elisabeth Elvestad. Rafael Crecente started his research career exploring how land consolidation could be a powerful approach for integrated planning and development of rural areas. His PhD "Land Consolidation in Galicia: Validation as an Instrument for Rural Planning." was the seed from which everything grew and later evolved at the LaboraTe. A novel view on an existing traditional and mostly technical tool in Galicia at that time, strongly inspired by the dynamics and innovative adaptations that land consolidation was establishing in other European countries such as Norway. Based on experience, both practical and research-based, Prof Sky makes recommendations on how all parties' emotions as well as social impacts can (and should) be considered in land consolidation. Consensus-building through mediation is often a better dispute resolution technique than a judicial process. Mediation can therefore be used as a conflict-reduction tool in land consolidation. This inspirational knowledge from *Jordskifte* (land consolidation) not only influenced Rafael Crecente's understanding but reinforced his determination to address spatial planning challenges from a socially centered approach.

Different research and action-oriented projects in that domain where further developed by Rafael Crecente, but as Prof. Magel reminded him at the end of the last century: "Not all is land consolidation." His quest for an integrated perspective of territory and the management of its resources soon made him aware of the need to consider a collection of hands-on instruments in the field in a flexible and coordinated way.

The next chapter is by Richard Eberlin, former Land Tenure and Rural Development Officer at the FAO Regional Office for Europe and Central Asia. It addresses multi-dimensional land banking as another key land management tool. The concept of "land" has multiple dimensions and facets. It can be understood as an institution, an object of policy, a legal subject, a matter of administration, an economic factor and as a physical entity. Depending on the objectives of a land bank, one or more of those dimensions and perspectives will become priority and influence its main features. The Land Bank of Galicia (at the time BanTeGal) was indeed the reason Richard and Rafa met for the first time. Rafa was one of the promoters of BanTeGal's Land Information System and the FAO showed its interest for that novel approach and its potential usefulness in some Central and Eastern European countries.

From the other end of the spectrum, in land-speaking terms, Associate Professor José Ambrosio Ferreira Neto and colleagues from the Universidade Federal de Viçosa in Brazil reflect on an Amazonian spatial planning tool in chapter 7. Namely *Sustainable Use Conservation Units*. Ass Prof. Ferreira, from the Rural Economy Department, added the vision and analysis of Brazilian social movements of access to land to the LaboraTe Lab's melting pot. He also provided Rafa and his research team with the unique opportunity to witness these movements closely in the field as well as affording great hospitality and friendship. As different as Brazil and Galicia are in terms of land structures, it was not surprising at all to find such an evident similarity in one thing - everywhere, land matters greatly.

Ass Prof. Ferreira focuses on global sustainability challenges in his contribution and reminds readers that environmental crises reignite disputes about land occupancy in the Amazon (and worldwide). Specifically, he questions whether the presence of native families in the Alto Juruá Extractive Reserve (the Alto Juruá Resex) in Acre state, Brazil, is in accordance with sustainable resource use, expressed in terms of low deforestation rates. He concludes that policymakers and national and transnational civil society groups (such as non-profit and for-profit organisations) should abandon the creation of closed and non-dynamic sustainability models and strategies.

The following chapter brings us back to Galicia for the 50th anniversary of UNESCO's Man and Biosphere (MAB) program. Associate Professor Pablo Ramil Rego, Director of the Biodiversity and Rural Development Institute at the University of Santiago de Compostela, together with his colleague Javier Ferreiro da Costa, researcher at the same Institute, journey through 50 years of the MAB Program. This program established a new approach to biodiversity conservation, based on a zoning of the territory and the application of a sustainable development concept. They reflect on the scope, results and drawbacks of the different projects aimed at the conservation and restoration of protected habitats and species. The authors also comment on actions undertaken in the Biosphere Reserves to improve the use of natural resources, their human residents' quality of life, knowledge and capacity-building. The Biosphere Reserves concept is a good analogy of the constructive dialectic between Rafa Crecente and Pablo Ramil. Both passionately debated how to preserve natural resources, particularly biodiversity, whilst facilitating its sustainable use and management, ensuring that the local population have a good quality of life.

Land Management Instruments finishes with a paper on land valuation and the challenges it faces in a region like Galicia, with impressive land fragmentation and abandonment in many parts. Manuel González Sarria, former President of the Expropriation Jury of Galicia (Xurado de Expropiación de Galicia) and currently technical adviser at the Miño-Sil Hydrographic Confederation (Confederación Hidrográfica del Miño-Sil) considers this situation of smallholdings (*minifundio*). He argues land managers are confronted with the Shakespearean question of: "To be or not to be?" when deciding whether to consider actual or potential land value factors and grasping their consequences. Manuel Sarria actively contributed to the *Masterterra*. He also participated in LaboraTe activities with his experience and knowledge of public administration, always eager to connect it and himself to academic and research dimensions.

The three chapters of the third section of this book, *Enabling Technologies in Spatial Planning: from Theory to Practice*, originate from another key characteristic of Rafael Crecente's vision. This was the acknowledgment that even though spatial planning is essentially a social process, new technologies should have a core facilitating role. From the very beginning at the LaboraTe, Rafa applied technological and methodological innovations to land management processes, understanding them as a means and not as an end in themselves. New IT technologies provided an opportunity to better map the territory, integrating more data sources and analysing them more accurately thus obtaining sophisticated models in less time. The spatial and multidimensional element of such a complex matter such as land management now had new powerful instruments. Interestingly, the novel use of those tools at the LaboraTe acted as a catalyser to bring theory and innovation into practice. They helped bridge Rafa and his team's research and innovation experience with real land management projects in Galicia.

Xurxo Loureiro, Nieves Pérez and Lucía Trancón, all land planners and research assistants at the LaboraTe, showcase some of the most representative and long-standing projects in the first chapter. They represent that line of work in the group: surveying local infrastructures and facilities along with municipal land use planning. They then go on to highlight the benefits *of* and the need *for* the integration of research and action (real plans and projects) in the field of land planning and management. It shows simultaneously how experience in real land management helps to identify problems needing to be solved by research and in hindsight how this ultimately enriches the research process itself. Over the past 20 years, the work undertaken by the LaboraTe's spatial planning team in the development of municipal urban plans has provided an experimental framework for working with different urban laws. This has provided the invaluable opportunity for first-hand observations of the difficulties surrounding their application and generated new knowledge with the aim of improving spatial planning.

Pablo Díaz, former LaboraTe software analyst specialized in the development of GIS tools, Inés Santé (Associate Professor at USC), Lucía Trancón and David Miranda (Associate Professor at USC and LaboraTe coordinator) relate a logical step forward in the next chapter. Spatial planning processes must consider the preferences of multiple stakeholders, who are demanding an increasingly active role in the processes. Public participation is necessary to help technical teams identify the most sensitive planning issues and improve the results of land use plans. 'People first' was (*and is*) a LaboraTe motto in real-life land planning projects. Technologies can also serve people in the same way by integrating GIS in public participatory tools, made possible by using Public Participation GIS (PPGIS). The authors present a web based PPGIS, designed, developed and deployed in real processes by LaboraTe as well as an assessment of its performance and elements for further development.

Last, but not least, the final contribution to the book aims to make progress in the application of new technologies to land use planning. It describes how land use simulation and optimization models, using geographic information technologies, can provide support to land analysis, diagnosis and optimal land use allocation. Inés Santé, USC Associate Professor of Spatial Planning and GIS, currently Director General of Rural Development at the Galician Regional Government and LaboraTe Associate Researchers Andrés García and Marcos Boullón, reflect on the complexity and slow development and implementation of urban and regional plans. They state that, among other factors, the difficulties are due to the limited technological and technical capacity of both public and private entities to undertake these processes. The emergence of Planning Support Systems has brought new ways to tackle them. Inés Santé and her colleagues overview tools developed by LaboraTe which were applied to several case studies in Galicia. The authors argue they demonstrate the capacity to provide more realistic, scientifically justified land use plans while reducing the time, effort and resources required for this task. Importantly, they highlight, without replacing the human role and the social dimension.

The thirteen chapters are proxies of pieces in a puzzle. That of Rafa's life and work, or of his life in work, since he passionately dedicated his entire energy to reflecting on how to achieve sustainable land use applying an old recipe: *learning by doing*. Pieces built up by some of his closest colleagues' critical contributions, generously donated to be shared with current and future generations. Hopefully, we will be inspired and encouraged by them to join Rafa's quest and collectively work out a lively and negotiated future in *our* land.

Quico Ónega

Land Policies, Culture and Institutional Design

A Life in Land: Lessons Learned over (nearly) 50 years of Professional Practice and Scholarship

Harvey M. Jacobs

Professor and Visiting Professor Emeritus, University of Wisconsin-Madison (USA) and Visiting Professor, Radboud University Nigmegen, The Netherlands.

Abstract

Land management is too commonly thought of as a technical undertaking, drawing from the physical and geographic features of land, and land policy is too commonly thought of as largely an economic undertaking where buyers and sellers act upon rational signals to make land use decisions. While physical, geographic and economic factors are key, early in my professional career I worked with local communities in the rural state of Vermont (in the northeastern region of the U.S.) to formulate their first-ever public sector land policy tools (most often zoning). What emerged from this experience was how land policy can serve as a proxy for a wide variety of cultural, social, and political values, many of which are difficult for individuals in communities to discuss otherwise. Rights of individual land owners, rights of neighbors, rights of future generations are all embedded in land policy, sometimes explicitly, often implicitly.

Here I reflect on my nearly 50 years of professional activity and how these initial insights about land policy became manifest in scholarship. Over the course of my career I have explored the feasibility of alternate land policy structures, the rise and impact of the right-wing, populist private property rights movement, how property is viewed and treated in the U.S. versus Europe, and conflicting visions for property in the 21st century. My research revolves around the argument that land policy is fundamentally social in nature. If this is true, then there are never 'right' and 'wrong' answers to the question – what should land policy be? – only negotiated answers. Thus a key role for the professional land manager is to help a complex multilogue (it is always much more than a dialogue) progress towards what will always be a temporary resolution in an ongoing discussion.

Leading Into a Life in Land

My life in land happened accidently. In 1973 I graduated the University of Buffalo with a degree in environmental design. This was a new program (I was in the second graduating class) that blended architecture, urban planning, policy analysis, and management, concentrating on creative, interdisciplinary thinking. As such, it drew from an eclectic set of materials including, for example, systems theory (Forester, 1971; Fuller, 1969; Meadows, Meadow, Randers, & Behrens, 1972), anthropology and cybernetics (Bateson, 1972), biological philosophy (Dubos, 1968), cultural history (Thompson, 1971), media theory (McLuhan, 1967), and socially responsible design theory (Papanek, 1971). But there was nothing per se in the curriculum about land management, land policy, or land issues.

My spouse and I wanted to leave Buffalo New York (a still vibrant, steel manufacturing based, industrial city) and move to the northeastern rural state of Vermont, which we had visited many times. I interviewed for several jobs there and was offered two – a social policy (health care) position and a comprehensive planning (land policy) position. The latter paid more and was in a nicer part of state – so that is where we went.

The position required me to work closely with local committees. Most of the people on these committees would be characterized as 'simple Vermonters.' What did this mean? It meant that most had not had higher education. They were farmers, forest workers, construction workers, shop keepers, maintenance personnel, first-level public employees (like postal workers). But I soon found out that they were deeply thoughtful, articulate (in their own truculent way), and respectful – of each other and of me (the young new-comer) (Sherman, Sessions, & Potash, 2004). My job was to help these local committees prepare their first ever land policy documents – primarily zoning regulations.

Knowing nothing about land management and land policy, I knew nothing about zoning. So why did I get hired? I knew something about public participation. And I had a personal commitment to the idea of democracy with a small d, the idea that people could, with facilitation, deliberate intelligently and make decisions 'in the public good'.

Those who hired me told me 'don't worry; you'll figure out the specifics of what you need to know'. And so began a five year post-baccalaureate, pre-doctoral apprenticeship, comprised of two to three night meetings per week, that set me on my life long professional course. My role was to work with local committees helping them translate already completed land use plans (done on a McHargian (1969) basis) into workable local regulations.

'Workable' meant that these that could be administered at the local level with a minimum of personnel, and that they would be adhered to by local people because they 'made sense'.

What transpired in these meetings was, for me, both fascinating and transformational. Ostensibly we were meeting to discuss 'mundane' issues – zoning district designations, land use categories, land use specifications, etc. Yet, conversations and discussions were never solely about these matters. Instead they were often, very often, about a more fundamental issue: what it meant to be an American. Specifically what were ones' rights as an American vis-a-vis the ownership and control of land? Did rights in land also carry responsibilities? And finally how did the designation of a zoning district, a use listing, or a specification affirm or deny these ideas about rights and responsibilities. But discussants were not of one mind about these issues. They brought the diversity of opinions that have long characterized American political and legal discourse (see, e.g., Ely, 1992; Alexander, 1997; McEvoy, 1998). To use Alexander's (1997) terms, some saw land as a commodity, while others saw it as propriety. Or put another way, some argued that it was the owner's right to do with land as he or she wished, while others argued for the rights of a broader and future community. We always came to decisions, but not before a great deal of discourse.

After five years I left Vermont to undertake Ph.D. studies at Cornell University. But there I encountered a conundrum. I met faculty and told them I wanted to study land policy and social and political theory. Most often the reply I received was: 'what does social and political theory have to do with land'. I was shocked. The last five years had impressed upon me that land ownership, control, and management were all about social and political theory: who got to say what about what, and how various interests (of which there were always multiple) were managed amongst themselves.

The Early Period of Scholarship

Fast forward fifteen years. As a young researcher I had been writing about aspects of land policy that seemed to me to have potential for addressing some of the core social and political conflicts that emerge in policy formulation and implementation. While my scholarship took several turns, this work continued through my career. At this point it was organized into two streams.

Stream one were investigations into what level of government should initiate policy design and implementation. Since the origins of modern land policy in the early part of the twentieth century, there was a tension between centralized goals and local implementation. Modern critics of local implementation see it as parochial, elitist, often outright discriminatory, and into the modern era an approach insensitive to ecological realities (Bosselman and Callies, 1972; Popper, 1981).[1] Drawing on Hardin's (1968) characterization, local control was framed as a form of the tragedy of the commons. Each individual local governing unit pursued its own self interest, but the result was a land management situation that was often understood as not in the greater social interest – socially, economically or ecologically. Yet localism in land policy is long-standing, sometimes by design and but also as a result of historical accident, and because land and its use is essentially local.[2]

There have been many efforts for regional or central control of land policy, but these have always been contentious (e.g. McClaughry, 1976). Interestingly, defenders of localism have generally come from the political right, while challengers have often come from the so-called liberal left. More recently the discussion about scale has become a bit more nuanced, rather than broad brushed, with even those on the political right asking exactly when and where local control is most appropriate (e.g. Anderson, 2011). Yet, even when achieved – that is when control has been taken back from local units and put into a more centralized structure – the results have been both mixed and difficult to replicate and expand. A classic example is the management of the Adirondack Park region in northern New York State. An early example of environmental regionalism (from the early 1970s), it has also been an area of continual conflict over who should have the authority to make decision over matters of local natural resource management (e.g. Harris, Gross, & Auerbach, 2012).

My contribution to this discourse has been to argue that for many reasons – historical, political, cultural – regional and central control were unlikely to be broadly adopted. While critiques of local control have many valid elements, instead of seeking to wrench authority away from local units, the same

1. Popper was an early and enthusiastic supporter of my work in this area and related areas, and remains so even though he himself has gone on to other foci of research.

2. In the U.S. governmental authority is constitutionally divided between the states and the national government. There is no underlying authority for sub-state, local governments (counties, cities, villages and towns). Authority for these sub-state units is only as broad as individual states allow it to be. So, land use policy authority is inherently a state responsibility. In the 1920s states began passing legislation which devolved this authority to sub-state units, first cities and then other units. Why did they do this? Because it was cities that were experiencing the pressing need to respond to technological, economic, and demographic change with local land use policy. So states gave away this authority without fully considering the implications of their actions.

effort should be expended towards a search for how to realize a more socially responsible localism (Jacobs, 1989a; Johnson & Jacobs, 1994; Armstrong & Jacobs, 1996; Krueger & Jacobs, 2016).

Lesson learned: participants to this debate are, for the most part, so fixed in their initial conceptions (about the good or bad of localism) that it is essentially impossible for them to entertain new ways of thinking about the subject.[3]

Stream two was about alternative land policy tools – most especially transfer of development rights (Jacobs 1994, 1997, 2009c), private, public-interest NGO land organizations known in the U.S. as land trusts (both conservation and community) (Institute for Community Economics, 1982; Foti & Jacobs 1989, 1991; Bassett & Jacobs 1997; Jacobs 2000, 2014), and land value taxation (Roakes, Barrows, & Jacobs, 1994).

Since zoning's inception in the early 1900s, it has been subject to stream of criticisms: it was too rigid (it was too inflexible), it oversimplified the complexity of local land use, it stifled market-responsive and appropriate land use activity, it was prone to bribery in administration, despite its appearance it gave a false sense of certainty because it was relatively easy to modify, it was actually relatively ineffective, and its distributed benefits and burdens to winners and losers inappropriately (Reps (1964) is one of a range of zoning's critics, though he is sympathetic one; Siegan (1970) is the classic critique of zoning's ineffectiveness at shaping land use).[4] These criticisms have continued through the decades as zoning continues to be a mainstay of local government land use policy (e.g. Fields, 2014; Fischel, 2015).

Eventually, a school of thought emerged that zoning should be replaced entirely with market-based alternatives (e.g. Kmiec, 1981). Many of these criticisms came to be grouped into a broader critique of command and control regulation (Baldwin, Cave, & Lodge, 2012).

Since at least the 1930s, there has been active exploration of alternatives or supplements to zoning, though this exploration accelerated in the post World War II era (e.g. Buttenheim, 1939; Kransnowiecki & Strong, 1963; Reps, 1967; Ellickson, 1973). Many of these explorations sought to address one or more of zoning's shortcomings. One that the professional community became particularly enamored of was transfer of development rights (TDR)

3. A former colleague, a committed regionalist, would often say to me that the concept of 'socially responsible localism' was an oxymoron; it was an impossibility.

4. Reps was my Ph.D. supervisor. I was one of his last doctoral students before his retirement, and the last student in the area of land policy.

(Costonis, 1973; Woodbury, 1975; Pruetz & Pruetz, 2007). TDR strive to retain the strengths of zoning, even increasing its effectiveness, while introducing a market-style structure of property rights trading, which if successful would provide more fairness to those being regulated, and more transparency in the regulatory process. Since its introduction as a concept, there have been thousands of feasibility studies for TDR, yet only hundreds of implementations (Kaplowitz, Machemer, & Pruetz, 2008).

In the same time period (the 1970s forward) there was increasing interest in non-profit (NGO) land organizations, both for land conservation and the provision of affordable housing. There are about 1700 land conservation trusts in the U.S. and about 250 community land trusts (those focused on affordable housing). In the early decades of the twenty-first century these NGOs began to internationalize (see Korngold, 2011; Stein, 2015 for conservation trusts, and Moore & McKee, 2012 for community trusts). When they were established and when they succeeded, they could be useful compliments and supplements to mainstream land use policy, but the fit wasn't always easy (Gerber, 2012; Schwing, 2012). And there emerged a critique about whose interests were being served through their establishment (Meiners & Yandle, 2001). Yet even the most successful of these organizations had a reach far less than public sector land policy. For example, the Vermont Land Trust, a conservation trust established in 1977 (and which I helped co-charter), has worked to protect over 231000 hectares. While admirable, this is only ten percent of the state's surface area, all of which is subject to zoning and other land policy approaches (see https://www.vlt.org/about).

Lessons learned: despite the criticisms of command and control approaches to public sector land policy, zoning (as the primary tool of this approach) is broadly used and widely accepted. Alternatives are enthusiastically discussed in the scholarly and professional literature, but rarely implemented. Despite its shortcomings, zoning and related land policy approaches endure precisely because they have proved to be flexible to changing institutional circumstances, and despite criticisms provide a degree of certainty among players in the land policy game – owners, neighbors, speculators, developers, regulators (see Jepson & Haines (2014) for an example regarding zoning's continuing adaptability; Babcock (1966) is the classic discussion of 'the zoning game'). Alternatives introduce too much uncertainty into the land management process.

The Rise and Impact of the Property Rights Movement

Then there emerges in the early 1990s, and I begin writing about, the so-called private property rights movement (Brick & Cawley, 1996).[5] Here was an on-the-right policy movement that was fascinating for at least two reasons. Most importantly, they were asserting exactly what I had been saying – that the right to own and control land was a central element of the American ethos (Ely, 1992; Bethell, 1998). Therefore policy conflicts over land were not just technical disagreements but rather deeply philosophical ones. Policy conflicts went to the core questions of what property rights existed, what these rights meant, who had control over these rights, and how the private and public spheres could and should interact vis-a-vis policy design and implementation.

Yet, most of my professional colleagues did not understand the importance of this development. Instead of how I understood the movement – as a major challenge to public sector land and environmental management – my colleagues saw the private property rights movement as an annoyance which could be dismissed and which would be irrelevant to the central legislative and policy issues at the national, state, and local levels in the U.S.

For a second time in my career I was in shock. How could my colleagues not see the importance and significance of these folks and their agenda (Jacobs, 1995; Jacobs & Ohm, 1995; Jacobs, 1996, 1998b, 1998c). During the 1990s the private property rights movement secured the passage of state-based laws in support of their perspective on property rights and land and environmental regulation in 26 of the 50 states (26 of the 48 continental states) (Emerson and Wise 1997). And after the 2005 U.S. Supreme Court Kelo decision (545 US 469 (2005)), they secured the passage of so-called anti-Kelo laws in 43 states (Jacobs & Bassett, 2011).

As I have emphasized to academic, professional, and public audiences through the years, these advocates are so impassioned in their conviction that they will continue in their advocacy, no matter public opinions polls or activist-based push back (Jacobs 1998a, 2010; Pellissery & Jacobs, 2017).

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5. I say 'so-called' private property rights movement because the movement has gone through a set of identity evolutions, referring to itself as 'the wise use movement', 'the land rights movement', 'the property rights movement', and 'the private property rights movement'. The latter two have become interchangeable, and now largely replaced the first two. For 'the wise use movement' see Helvarg (1994) and Echeverria and Eby (1995); for 'the land rights movement' see for example Yandle (1995).

For the next two decades (until the present) the core of my research has used the advocacy actions of the private property rights movement to explore a broad range of issues (Jacobs, 2003). Among these are the deeply embedded role of property rights in American land policy (Jacobs & Paulsen, 2009), social conflicts over the very meaning of ownership and the rights it engenders (Jacobs & Bassett, 2011), and how social conflict (fighting) over property rights is likely to be an ever-present component of American social and political discourse (Jacobs 1999, 2009b, 2010).

Lessons learned: property rights, especially privately held property rights, are a highly ideological issue in the U.S. There are scholars and activists who view individual ownership of property as a fundamental issue tied to the American revolution, and as such are highly and deeply concerned about the evolution of modern day (post 1970) land use and environmental policy (mostly regulation). Proponents are creative and adaptive, constantly adjusting their approaches to contemporary issues and the failures and successes of their efforts at the national, state, and local levels of government. They will continue in this activism into the foreseeable future. Therefore social dialogue about the reasonableness and validity of public sector planning will be ever-present in American policy discourse, with planners and plans subject to attacks about how public sector land use management comports with American ideas about individual liberty and freedom.

Comparative Planning Research

In the process of exploration, interesting tangents have presented themselves. One of the most fruitful and enjoyable has been comparative scholarship about Europe (Jacobs, 2006, 2008a, 2008b, 2009a, 2012, van der Krabben & Jacobs, 2013, Vos, Jacobs, & Samsura, 2019). Americans have long been fascinated by European approaches to land policy and urban management. The invention of zoning in the early twentieth century came about after a study trip to Europe (Hirt, 2015). In the modern era, all aspects of U.S. land problems are mirrored in Europe, though handled differently, often more effectively (e.g. Strong, 1979; Beatley, 2000; Hamin, 2002; Harrington, Morgenstern, & Sterner, 2004; Lewyn, 2009).

My own contribution to this discourse focused on two elements. First, I sought to understand why it is that the core concept of property rights is understood differently, and most especially why state action that impinges on private property rights has differing degrees of deference from landowners. Second, I asked (as the Europeans themselves were asking) if there are aspects of the U.S.

experience in land policy and land development that might be useful to Europeans, as the European legal and policy landscape is changing.

What is striking is that the 18th century American and French revolutions began with similar ideas about property, the rights of the individual, and the appropriate role of the state. The founding documents from both revolutions provided for the shielding of an individual's land from unreasonable governmental expropriation, by requiring that government prove that the physical taking of land was for the public good, and that the individual would be compensated a fair amount for the expropriation. These ideas stayed similar through the eighteenth and nineteenth centuries. But then, in the early twentieth century, they diverged.

In the period of the late nineteenth and early twentieth centuries both Europe and the U.S. were experiencing rapid urbanization and rapid industrialization (and it was the latter that was fueling the former). It was this rapid change which prompted cities to initiate modern land policy (often in the form of land use regulations). Until the 1920s these regulations were treated similarly – that is, there was little constraint on cities (government in general) developing and implementing these regulations and landowners were required to comply with them for the greater good. Then in the early 1920s the U.S. Supreme Court took up the issue of whether there was a limit to how much the government can regulate private land. In the 1922 case of Pennsylvania Coal Co. v. Mahon the Court found that: 'The general rule is that while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a taking' (260 U.S. 393, 1922: 415). That is, regulation that is too onerous (that 'goes too far') could be viewed by the courts as equivalent to physical expropriation and thus while allowed would require the regulating unit to provide compensation to those impacted. Interestingly the Court did not specify the precise place where regulation went from acceptable to unacceptable.

The impact of this case has echoed since its decision. While for cultural reasons governments in the U.S. were always cautious about developing and implementing too-strong land use regulations, now they had an added legal reason.

For the remainder of the twentieth century nothing similar transpired in Europe. Governments remained empowered to develop and implement land use policies (land use regulations) absent any ruling or interpretation that regulation might be judged to be the equivalent of physical expropriation. Added to this were several cultural elements. Europe as a region has twice the population on half the land area of the U.S. So the populace is, in general, more aware of the need for regulation. And Europeans attitudes toward 'the state' are decidedly different than American attitudes. While in the U.S. many people hold a skeptical view of public authority, public power, and public professionals, in Europe, it is almost the opposite. This is borne out of history. In Europe much of the land was owned by an aristocracy until the modern era. It took popular (democratic?) revolutions to wrest control away from the elite. Out of these actions an attitude developed (most pointedly in northern Europe) that government was a force for good on behalf of 'the people'. Urban and regional plans were to be respected and followed, public professionals who developed and enforced these plans were to be trusted, and most pointedly, individuals did not assume to have rights in their land which put them in a preferential position vis-a-vis the interests of the broader community (embodied in the state).

A shift occurred in the early twenty-first century. Largely as a result of cases brought before the European Court of Human Rights, the Court began to articulate a limit to public regulation and to define a basis for private individuals to seek compensatory action for 'onerous' regulation (Ploeger & Groetelaers, 2007; Allen, 2010). All of this was directly analogous to the 1922 Penn Coal decision in the U.S. In part because of these decisions, and in part because of other factors changing in the public planning and private land development sectors, there has emerged an interest in U.S. planning practices. The U.S. is a place with strong market forces, strong property rights, and yet a broadly present public planning system.

Lessons learned: property rights, especially private property rights, hold much of the same cultural value in the U.S. and Europe. What is different is how the legal systems allowed for the public planning systems to interact with these private rights. For much of the twentieth century U.S. local governments felt constrained, while European governments did not. The legal environment in Europe changed significantly in the early twenty-first century. As a result of this change European governments are looking to the U.S. for lessons in planning in a more market friendly, developer led situation, with sensitivity to the rights of owners. Yet, at least initially, it is not clear how many lessons there are. Europeans still carry the legacy of the twentieth century with them, in their expectations of governmental action and individual behavior vis-a-vis 'the social good'.

Towards a Theory of Property Rights for Land Management

To the surprise of many, the twenty-first century began with a renewed focus on property rights globally. Why this was true can be attributed to several factors: the globalization of the U.S. private property rights movement; the general rise of the populist political right globally, and the role property rights have traditionally played in right-wing populist theory and advocacy; country and region specific transformations, for example, the fall of the Berlin Wall in the late 1980s, the break up of the Soviet Union and the end of apartheid in South Africa in the early 1990s.

Yet significantly much of the renewed focus can be tied to the work of one individual. In 2000, De Soto published a non-academic book about mega-cities, informal settlements (urban slums), urban poverty, and economic development. His argument captured the attention of powerful interests – those at the World Bank and the World Economic Forum (Davos). His argument was a simple one. The reason there are extensive urban slums, urban poverty, and inadequate economic development is that residents lack ownership of the land on which they reside. They do not own their property; they have no property rights. And because they do not, they can not use property and property rights the way those in developed countries can – as collateral to jump start settlement upgrading and small-scale economic development.

Whether De Soto is correct in his assertions is one thing (he has been subject to wide-ranging critiques; see for example Gilbert, 2002). But whether he is or not, combined with the country and region specific changes noted above suddenly property rights and property rights reform were once again part of a global policy reform discussion (in a way that had not been since the 1960s and 1970s, when the focus was on rural land reform in Latin America, Africa, and Southeast Asia).

For these and other reasons there emerged a robust renewal of scholarship about property. These are wide ranging in perspective and include among many examples, Alexander (2006), Alexander et al. (2009), Freyfogle (2007, 2010), Purdy (2005, 2010), and Heller (1998, 2008).

My own contribution to this discussion has had two related foci: one, on the social and legal institution of private property (in contrast to state property, common property, etc.), and the relevancy of eighteenth century conceptions of private property to the spatial, social, and economic conditions of the twenty-first century. In this vein I have explored how private property is likely to evolve in the next 100 years (Jacobs, 2004, 2009d), the functionality of private property when viewed through the lens of contemporary debates on human rights (Jacobs, 2013), the relationship of private property to new spatial issues such as climate change (Jacobs, 2018), and understanding the debate over private property as an ongoing, contentious dialogue about who has claims on property, and what 'private' even means (Jacobs, 2020). Understood this way, I now see that earlier work was part of this exploration – trying to understand what was fair in land policy (Jacobs, 1989b), and broad-brush speculation about how land planning (land management) might change in the twenty-first century (Jacobs, 1992).

Exploration of this sort is never a sole exercise. It emerges from a community. I was most affected and influenced by the work of two friends in particular: Davy (e.g. 2012, 2019), and Needham (e.g. 2014, and Needham, Buitelaar, & Hartmann, 2019). They strongly supported my investigations, and as importantly challenged me in my conceptions, while presenting me with multiple opportunities to present my work, even as they disagreed with some of my conclusions.[6]

What are my conclusions?

- That the very idea of what constitutes private property has always been socially contested.
- That part of this contestation are radically divergent views of the integrity of the private property rights bundle, and the rights and powers of the state to impact upon the rights in this bundle absent compensation for such action.
- That private property has been fundamentally re-shaped by changes in technology and social values.
- That the contestation over private property has, in general, led to a restriction of the rights of the 'owner', and an expansion of the rights of others – neighbors, society, the eco-system.
- That this dialogue about the rights of the owner and the rights of others is on-going, and never really settled. Instead it serves as a proxy for debates about other social values – e.g. the meaning of citizenship, liberty, freedom, social responsibility.
- That most of the participants in land management – owners, renters, neighbors, professionals, decision makers – have limited knowledge about the core theoretical issues in property. They too often approach social contestation over land management (land policy) with limited understanding for what could be undertaken to address a broad range of concerns.

6. Davy also facilitated my fellowship at Bielefeld University in 2011-2012, and Needham helped me to more deeply understand The Netherlands through many wonderful day tours throughout the country during the period 2012-2019. In addition, I have to acknowledge and thank my friend and colleague Erwin van der Krabben, who arranged for my visiting professor relationship at Radboud University Nijmegen, The Netherlands for the period 2012-2019. We spent many an enjoyable hour talking through issues in Dutch, European, and American planning and planning education.

Lessons learned: Land management (land policy) affects a real thing. What is done to land today impacts future generations, but these generations are not at the table to be part of the management dialogue. And most of the participants to this multi-logue do not understand – in an explicit way – the concept at its core, property: what property is, what it is comprised of, how it comes to be, how it has changed over time, and thus how it can change into the future. A key role for the professional land manager is to make all this explicit, and in so doing to use it to help the multi-logue progress towards what will always be a temporary resolution in a continuing discussion.

Lessons Learned: A Life in Land.[7]

Nearly 50 years later the lessons I learned from those 'simple' Vermonters endures. Land matters. People, regardless of whether they are poor or rich, rural or urban, formally or informally settled, care about land, and thus land management and land policy; they care about property. Wars are still being fought over territory, people deprived of a homeland are homeless.

The promise of property as land is that it should provide a degree of security, equity, and legacy for its owners. Thus while land management and land policy draws on technical data for its foundation it is not, nor can it be, solely a technical exercise; it is always a social exercise. Land management (land policy) is social policy.

Land management and land policy matter because they set the rules by which land may be used, and establish the relationships over land by the 'owner', neighbors, society at large, and future generations. There are no (and never will be) 'right' and 'wrong' answers to the question – what should this policy be? There are only negotiated answers, answers that in the best of circumstances emerge from a democratic multi-logue sensitive to the needs of the owner, neighbors, society, and the future. These answers are as correct as they can be at the moment, and always subject to change. While frustrating, it is what makes a life in land so rewarding as an arena of professional practice.

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7. In more ways than I could ever list I am indebted to my spouse, Susan, who has, throughout my career, always supported and cheered me on. While I too often go on for too long about how 'it really is all about land' (and she is not so sure I am actually correct), she always listens, prods, and engages me. The insights and lessons learned detailed in this chapter would not have been possible without her.

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Changing the game: thoughts on the institutional roots of land use challenges

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Abstract
Land management is responding smartly to the needs of the human-nature-interaction that we call landscape. Because of the strategic nature of any response, a range of options are considered before a decision is reached about how to act. International collaboration between academics and practitioners helps to expand the repertoire of known options and improves the understanding of the complexity of the interaction between humans and nature. This chapter discusses how small institutional settings can have huge consequences on landscapes: sprawling cities, forest fires, peripheral locations of airports and overproduction of offices can be explained by considering institutional drivers. Land management must address the root cause of land use patterns to prevent only the symptoms being treated. Game changing solutions involve preserving open spaces and promotion of spatial quality. Rules, through people, affect land use and when the latter is problematic, the first may need to be reconsidered.

Keywords: functional structuralism, institutions, institutional design, game.

1. Introduction

Land management addresses imperfections in land use, in the light of our ambitions for the future. It seeks to take good care of land as a resource and prevent improper treatment of land at the expense of future generations. Land management is a confluence of land policy (ambitions such as poverty reduction, sustainable settlements, sustainable agriculture, etc.), land information and land administration structures (land registries, cadastres, land use regulation), which

Williamson et al. (2010) contend are operated by influencing land tenure, land value, land use and land development.

Although many people would say that ‘problems’ drive land management, ‘problems’ are really only gaps between ambitions and reality. A problem exists because we have ambitions; without ambitions we would not consider anything problematic. Our ambition is to have a reliable and high-quality food supply, which is why erosion, the flooding of rivers, pests and salination are called ‘problems’. In themselves, these phenomena are just processes and situations to be observed.

Problems are the flip side of ambitions but work better in a politically strategic way. The creation of problems, the rhetoric conveying their pertinence and the advocacy for action are at the core of generating coordinated action. The creation of these stories about what exists, what could exist and what should exist leads to the coordination of actions across groups of people who do not know each other. This, according to Harari (2011), is the reason why the human species came to dominate the world. Fire enabled us to turn forests into arable land, cook food (and thus have the time to digest the food), and to scare away predators. However, stories about what ought to be done persuade millions of people into corresponding behaviour.

Today, land management problems play an important role in the stories that coordinate the political will, formations and consequent actions of the human race. Flood hazards, food quality, erosion, pollution, drinking water, accessibility, greenhouse emissions, forest fires, wars and refugees are all related to land use patterns and in turn influence land resources (IPCC, 2019 Climate Change and Land).

This chapter explores the ways in which land management problems can be seen as symptoms of the deeper institutional - and thus systemic - properties of society. We claim institutions are vital to understanding how problematic land-related activities occur. As we will see, heritage laws, registries, subsidy arrangements, local finance rules and global money flows cause distinct land use patterns, which land management seeks to redress.

These institutions are not tools for land managers to treat illnesses: they may themselves cause the illness.

Land managers can easily find themselves fighting symptoms instead of root causes. As all medics know, it is helpful to suppress a high fever, but the infection or inflammation that triggers the fever must also be treated. Addressing the root causes of problems may not be the prime task of land managers, as it may be well outside their sphere of influence. It is a duty nonetheless to search, reveal and expose the problems underlying the symptoms. International exchange of academics, practitioners and students who examine local problematic situations can help to identify why land use problems emerge.

2. The institutional side of land use problems

2.1. Sprawl

For decades, the USA debated a land use pattern that led to growing concern. In this country where personal car mobility was intended to be accessible to everyone, a pattern of very low-density of urbanization became dominant. Businesses, shops and houses were spread over very extensive areas of land. This pattern would later increasingly be called 'wasteful' (Brodsky, 1973; Ewing, 1997; Batty et al. 2003).

Sprawl became the synonym for the American inability to generate sustainable cities. Low density urbanization has many consequences apart from making an unnecessary intrusion on the natural landscape. For example, people must live together in sufficient densities for public transport systems to be viable. Sprawl calls for individual car use. Notoriously sprawling cities (Atlanta, Houston, Dallas) are known to have the highest car mileage per person and fuel consumption per capita (Newman and Kenworthy, 1989), which are correlated with high levels of air pollution and associated health risks (Frumkin, 2016).

Sprawl, the debate goes, must be curbed. But how?

The book entitled "Place Matters" takes a particular perspective on sprawl. The authors (Dreier, Mollenkopf and Swanstrom, 2013) see sprawl as the meta-outcome of rational micro-decisions by groups of people. US sprawl is not a spontaneous pattern by unregulated building activities of individuals. Instead, it is sanctioned in zoning plans. By revealing the rationality behind low-density zoning, "Place Matters" shows the root cause.

Zoning plans are made by cities. What is a city? It is a legal entity, in which the inhabitants are placed in charge of group interests such as waste collection, sewer systems, schools – and urban expansion. When a community needs more homes, the city makes a plan about where to build them. This is a rational, community led process. If people object to sprawl, the low-density zoning would, in theory, stop.

However, the creature we call 'a city' has a rationality of its own. Since the Reagan administration (Caraley, 1992) deemed it undesirable to redistribute local tax dividends at the state level, US cities have been financially 'on their own'. Local tax systems must pay for local responses to problems. Hence, cities exhibit a wish to maximize the ratio between taxes incurred and outgoing expenses. In addition, because building land is readily available in the latest suburban expansions, it is relatively easily for residents to leave one city and live in another. They can even create a new city entity along the urban fringe that may still be county land ('unincorporated'). As a consequence, many metropolitan areas are patchworks of dozens or even hundreds of city governments.

Sprawl and administrative fragmentation in the Los Angeles metropolitan region are notorious.

This Balkanization causes an incentivized structure in which cities compete with each other to retain the maximum number of wealthy residents and to keep problematic, costly residents out. The natural answer to this competition is to zone all land within the city limits for the types of houses that only the wealthy resident can afford, i.e. separate structures surrounded by large lawns. These zones need little investment in road and sewage systems, generate low policing or social counselling costs and generate high real estate taxes.

The root cause of sprawl, the authors of "Place Matters" show, lies in the fragmented and financially competitive administrative geography of American metropoles.

German and Dutch cities, by contrast, cover large areas that allow villages, agricultural landscapes, brownfield sites, town centers, business parks and residential land use to be planned from an integral perspective – and within one financial budget, enabling city income from profitable land development to make up for losses elsewhere, for instance on contaminated post-industrial brownfield sites.

2.2. Forest fires

The great Californian drought, an extreme and continual decrease in the natural precipitation pattern (Seager et al., 2015), is largely considered to have caused the forest fires raging in the state in 2018 and 2019. By contrast, the forest fires in Spain and Portugal (Nunes et al., 2016; Mateus and Fernandes, 2014) have an institutional story behind them. Forest fires in natural landscapes can be natural, necessary and beneficial for the rejuvenation of ecosystems. However, when the landscape is cultivated, the gravity of the effects on humans increase, but the influence of humans in generating the fires must also be understood.

The countryside in Spain and Portugal (not unlike in France and Italy) has witnessed decades of depopulation. Agriculture has become both less labour intensive and less profitable, causing young people to move to the city once they reach working age – or even earlier. The combination of two causes sets off the following train of unfortunate developments.

After departing, the young adults are eventually faced with their parents passing away and the land being then left to them through inheritance law. If earning a living from agriculture was not attractive when they left, the prospect of leaving their city life to exploit only a fraction of their parents' farm is even less attractive. In many countries, the heirs would sell the land. However, in parts of Spain, such as Galicia, the land market is dysfunctional due to the absence of a reliable land registry and to rules that make transfer of the property to a buyer a laborious process. This results in agricultural land ownership becoming fragmented among an increasing number of absentee-owners.

The resulting absentee-owners, who cannot or do not want to sell or run the farm, choose the highest profit with the least investment: planting eucalyptus. Planting eucalyptus on small plots generates some revenue from the timber, while the trees do not need much care. Eucalyptus leaves, however, do not decompose well and have a high oil content. The plantations thus accumulate a thick layer of leaves that burn very well.

The root cause of forest fires in Spain and Portugal must be sought in the inheritance laws and the failing prerequisites for a land market, which drive absentee-owners to plant non-native trees that aggravate fires.

2.3. Peripheral airports

Some airports are currently located at long distances from the city they are supposed to service. The associated noise and safety considerations may justify the relatively long distances between airports and some cities. However, some airports are nowadays located quite peripherally.

Yogjakarta is a special district in Indonesia with key cultural heritage in the form of temple complexes. The Indonesian government is expected to appoint this district to be one of the national key areas for tourism. The current airport lies at the south edge of the capital city (also called Yogjakarta), engulfed by a peri-urban landscape of scattered houses and rice fields. It is a compact airport that will not be able to handle the growth in tourist and business flights and their passengers. The airport will need larger runways to enable larger passenger planes to land.

Instead of expanding the present airport, the choice has been made to build a new airport (Rijanta, et al., 2019) at a distance of 70 kilometers from the city of Yogjakarta. The airport will probably open without rail transport connecting it to the city, for institutional reasons.

Land is less of an economic commodity in Indonesia than in Europe. Land can be owned as family property for centuries and ancestors may be buried there or said to live there still. For this reason, the land owners around Jakarta airport do not want to sell the land and the government does not want to expropriate the land. If the city wants a bigger airport it needs an entirely new location, free of vested interests.

The Yogjakarta district has special status within Indonesia, as a sultanate, and the sultan of Yogjakarta historically has rights in parts of the region. The proposed site for the new airport is owned by the sultan. However, his land lies at a greater distance from the city than is necessary for an airport.

The root cause of the new Yogjakarta airport being so peripheral lies in the land rights and the sultanate.

2.4. Interstate traffic

The metropolis of Portland, Oregon, embraces the Columbia river. The Central Business District (CBD) lines the southern river bank and the suburbs fan out in the hills lying behind it. The high rises of the CBD can be seen when entering the city from the north by car, when one of the many high bridges over the Columbia must be used. An ever-increasing population lives on the north bank but wants to commute into the CBD. The bridges have become insufficient to accommodate the more than 140,000 vehicles that cross them every day (Oregon Secretary of State, 2019), and they must be replaced. The Columbia River Crossing (CRC) project projects very high replacement costs.

There is an institutional reason for the popularity of living to the north of the Columbia river. The Columbia river is the boundary between the state of Oregon and the state of Washington. Both states have made different choices in their tax regimes. While Washington state applies sales tax, Oregon does not. By contrast, Oregon collects considerable property taxes and Washington state does not.

The result of the state border and the differences in tax regimes is that *Homo economicus* prefers to live north of the Columbia river, but to work and shop south of the river. Hence the irrational growth and geographical imbalance between stores in Oregon and houses in Washington. And hence the continuous expansion of road capacity across the Columbia river.

The root cause of the traffic and urbanization across the Columbia is the difference in tax regimes.

2.5. Unwanted land use at national and city borders

When sites are needed for landfills, wind farms, nuclear reactors or incineration facilities, the fringes of the decision-making authority receive special attention. First, there is a psychological aspect to these fringes. In City Halls, maps can be found showing the centre of the City Council's attention, and the periphery. Similarly, national governments have a psychological bias toward what is considered the territorial centre (which can be geographically acentric) and periphery. Second, the fringes are easy victims for unwanted land use because half the circle of influence lies within a jurisdiction that will not have a say in the decision, namely the neighbouring city or country.

As a consequence, unwanted projects are increasingly found in peripheral areas, even when these may not be the best location in the light of other considerations. The boundaries between cities and nations may be quite arbitrary, but they nonetheless affect land use because of their psychological and power-related effects.

The root cause of unwanted facility sites is the (often rather arbitrary) location of the administrative boundary.

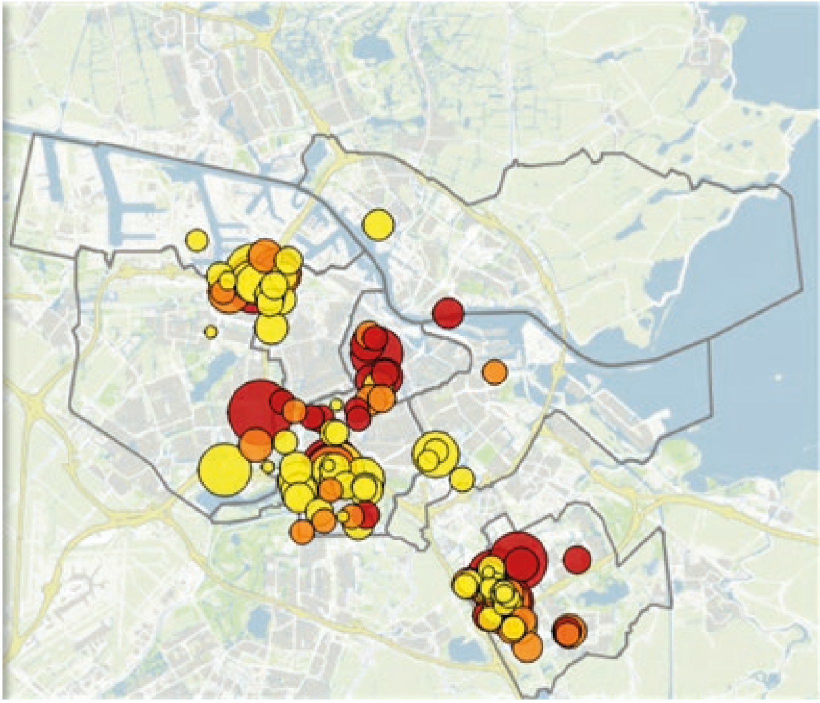
Nuclear plants tend to be located close to coastlines (because of seawater used for cooling) but also the inland borders of Belgium, the Netherlands and Germany.

2.6. Oversupply of office buildings

Real estate in the form of buildings is not only constructed for the purpose of selling or leasing the floor space. If it were built for these purposes, demand and supply would be well balanced, because the absence of demand would stop the flow of capital into the hands of the developers. Nonetheless, overproduction of office floor space occurs in some cities.

Research by Janssen-Jansen, Hartman and Needham (2012) has shown that the production of offices can be driven by other institutional reasons. In the office property market, large investors may not be interested in actually renting out the floor space. Regulations provide incentives to firms that handle large amounts of money to convert their financial assets into real estate. Offices can provide safe markets for storing capital. As a consequence, offices can be built in the absence of any demand for floor space. Taxes are based on the value of properties, not on their actual profitability, and all parties may therefore agree to build more offices.

The root cause of office overproduction is the need for large firms to invest in bricks and mortar.



Vacant office floor space in Amsterdam. Size of the circles indicates the area occupied. Red=100% vacant, orange=50-100% vacant, yellow=<50% vacant. Source: gemeentemakelpunt.nl

3. Deliberate institutional strategies

For people who became aware of the power of institutions, patterns become more visible. Dutch laws demand that car tunnels longer than 250 m have expensive evacuation escapes, and apartment buildings higher than 3 floors have elevators. As a consequence, tunnels tend to measure just below or well above 250 m and there are few buildings of 4 of 5 floors. In Greece, local laws exempt property owners from paying taxes while the building remains unfinished. The consequence is that there are many structures with unfinished top floors that will never be finished because this saves taxes. Environmental laws and permission can make landowners suppress rather than encourage ecological values in order to prevent restrictions to land development.

In their inquiry into the impact of formal regulations on everyday decisions made by people, Van Dijk and Beunen (2009) wondered rhetorically "Should we take institutions as a given with individuals adjusting their behaviour ('structural functionalism'), or should we take the institutions as being subject to constant adaptation by the individuals ('functional structuralism'), a distinction that the sociologist Luhmann was one of the first to put to debate (Luhmann, 1966). (...) a system emerges because of, or thanks to, a certain cultural constellation."

When we combine the notion of institutions that have considerable influence together with the fact that they are merely human inventions that can be redesigned, we can conclude that institutions can be deliberately manipulated to achieve a desired effect. Three examples are given to illustrate this.

3.1. Securing spatial quality in river management projects

In 2007, the Netherlands embarked on a large scale programme of river management projects: Room for the River. Climate change would make the current capacity of the country's lowland rivers insufficient. The predicted extreme water levels, the Dutch ministers decided, would have to be counteracted by adjusting dike heights, the heights of the floodplains and widening the river bed in some places.

This would surely have far reaching consequences for the farmers using the floodplains and for residents of the river banks. Dike reinforcement projects in the 1990s met with fierce resistance, delays and overrunning costs.

The ambition was therefore formulated to 'improve the capacity of the rivers in such a way that the river landscape will be more appreciated after the project than before' (Sijmons, et al., 2017). With this double ambition (safety and beauty), recreational and ecological claims on the land between the dikes had to be balanced with river management considerations. Thus, the engineers of the water management organizations would have to expand their view on what defines spatial quality. How could this ambition be achieved?

The strategy developed was as institutional as it was successful: the Q-team. The Q-team was a group of 5 highly esteemed landscape architects whose influence came from the following procedure. All projects included within the program needed approval from the program director to proceed and be granted the funds to implement a new project phase. The Q-team advised the programme directors about the spatial quality of the projects, helping them to be aware of any quality deficiencies before deciding to give a project the green light. In order to prevent project directors from running into problems when proposing their projects to the programme director, the Q-team would visit the project teams on several occasions to help them improve the spatial quality of their plans.

With their unique advisory position (both advising the programme director and the project teams), the Q-team achieved awareness of and aspiration for spatial quality throughout the field of professionals working on preparing the rivers for climate change. With this institutional arrangement, the changes to the river became much more than a programme based on the rationality of water management engineers alone.

Inserting the unique figure of the Q-team was an institutional-systemic strategy for a land use purpose.

3.2. Conserving open spaces

Metropoles across the world aspire to preserve green spaces. Even before the benefits of green spaces for health, wellness and exercise became backed up by extensive scientific evidence, London chose to preserve a Green Belt, Copenhagen chose to strive for Green Fingers, and the Dutch Randstad region embarked on a Green Heart doctrine.

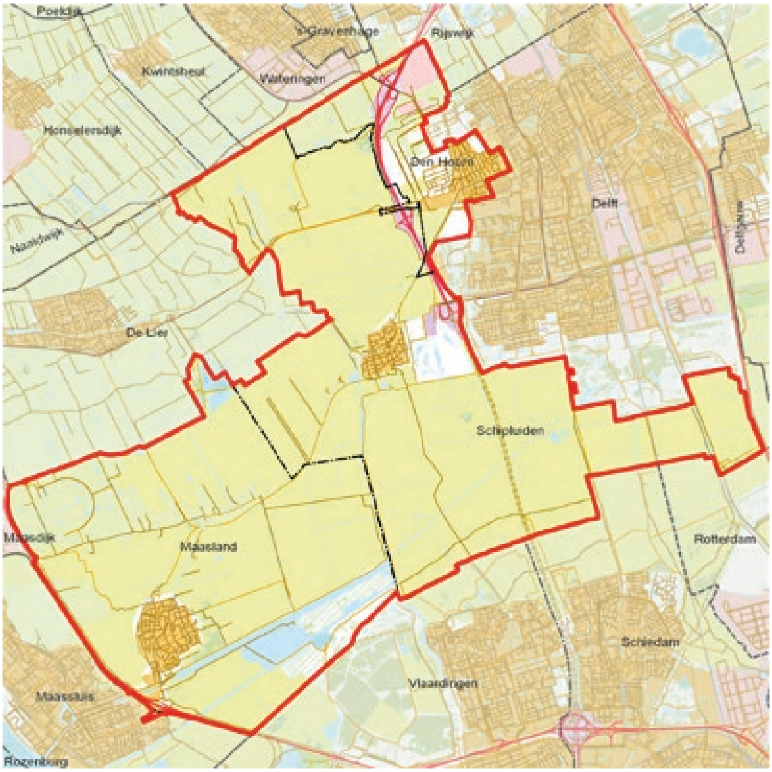
The instruments used to realize the ambitions to prevent urbanization of certain parts of a country are, again, inevitably institutional:

— *Rule of law* helps when the legal framework provides a mechanism for higher governments to deny a city from zoning urban land use. This is the case in countries where individuals do not have the right to develop their land *a priori*. That right must always be permitted by the city. As a consequence, when the right to develop land is denied, the individuals do not have to be compensated. The Dutch system works this way, and a national designation of the Green Heart gave cities within a specific boundary very limited room for urbanization (Koomen, Dekkers and Van Dijk, 2008). Even then, the Green Heart and the Dutch National Nature Network also purchased thousands of hectares of land:

— *Purchase* of full bundles of ownership rights, including the right to erect buildings, turns the land over into national hands; this is obviously a costly measure. Purchase in fact fully compensates all loss of rights and is the only way to stop urbanization when the above option is not legally available. When both permit denial or purchase of development rights are inaccessible (due to the lack of legal possibilities or of money), there is the option of disincentivizing:

— *Urban Growth Boundaries* (UGBs) are an American instrument used to slow down urbanization of surrounding land. Inside UGBs, sewage, policing and road infrastructure are extended to urbanized plots. Outside UGBs, a less favourable regime on these services applies. The resulting decrease in value at the boundary is contested but property owners within the UGB benefit from capital accumulation. Portland (Nelson and Moore, 1993) and Seattle (Robinson et al., 2005) adopted UGB policies for a higher density of urban land use and to preserve peri-urban landscapes of high agricultural and ecological value.

A special strategy was applied in the green area separating Rotterdam and The Hague in the Netherlands (see Van Rij and Korthals Altes, 2008). The urbanization pressure from both cities on the areas was very high. Despite what was stated in section 2.5, the area would be vulnerable if the rural municipalities merged with surrounding cities and became their peripheries. The farmers and country people living there would have very little say in the land use policies of these surrounding cities. The vulnerability was relieved by merging the fragmented rural municipalities into two rural administrations: the municipality of Midden-Delfland and Westland. Thus, the people living in this green area would remain in charge of zoning what they saw as appropriate. Rural ambitions are not diluted by urban considerations.



The green municipality of Midden-Delfland, which sits between The Hague (north) and Rotterdam (south), was specifically created to empower the people living in the area to resist urbanization.

Stopping urbanization is manipulating the rules of land development within the constitutional possibilities.

3.3. Developing sites despite soil pollution

Historical soil contamination may freeze high-potential building locations. In many countries, such as in the Netherlands, previous industrial usage has contaminated the soil, but any new site owners become liable for pollution leaching into the ground water. This is a risk not many developers are prepared to take. As a consequence, many sites remain vacant, even when potentially highly profitable.

In the city of Zwolle, two former industrial sites in the city centre remained vacant for this reason: a shipyard and a former paint factory. The sites lay in close proximity to shopping streets, restaurants, parking structures and a popular cinema. Despite their potential to make the city more compact and reduce the need for green-field development, the sites lay idle for decades.

Two entrepreneurial-minded civil servants designed a fix. They offered developers the possibility of their liability in case of groundwater pollution being waived. After cleaning the topsoil and installing an impervious surface (to prevent contamination from leaching down), developers could pay a sum of money to be acquitted of all other liabilities. The sums paid were placed in an earmarked city fund that would finance an integral groundwater cleaning approach: a sensor system, and strategic groundwater extraction points that would divert any contaminants away from sensitive sites such as drinking water extraction.

These two polluted sites in the Dutch city of Zwolle were successfully cleaned and redeveloped after liability for future groundwater contamination was waived for developers.

By adding this new institution to the existing network of rules and liabilities, land developers decided to construct apartments on the sites. The area has thus become a new, lively and much appreciated walkable and cyclable district.

The root cause of polluted sites being avoided by developers is the liability for future leaching. By taking that risk away, the city of Zwolle freed key sites for high quality residential development.

4. Discussion

Institutions shape human behaviour that shapes land use. From a distance this can be perceived as self-organization: many individual decisions (interdependence between land users and land managers) result in an overall result (the landscape) that was not desired or orchestrated by any actors. This is a logical yet unplanned aggregated result. No one person is responsible for forest fires, sprawl or office overproduction. They are the result of rational human behaviour in the face of establishing the rules of engagement: administrative boundaries, financing realities and personal cost-benefit analysis.

When we consider the examples given in this chapter, it is hardly surprising that many authors have presented land use patterns as the outcomes of a game (Turner, 1990; Nelson, 1990; Van Dijk, Aarts and De Wit, 2011, Razin, 1998; Koch, 2015). The land use problems that land managers address have an origin. Considering the institutional history of the problem rather than the current problem itself (ambition versus reality) is the way to find solutions. When we change the game, we change the outcomes.

By triggering, enabling or constraining (distinction by Zhang, de Roo and Rauws, 2019), the rules shape the land use *per se*, and when deviating from our societal aspirations about *what should be*, land management is about strategically manipulating the game in order to improve outcomes. The question is which elements in the game can be targeted.

Targeting the most feasible and most transformative parts of the game requires a basic awareness and insight in the peculiarities of the domestic or even regional context. This is never straightforward. Just like a fish is not aware of water, land managers may not always realise how the game around them works – and that it does not have to stay that way. The game can be changed.

International collaboration and cross-national learning create awareness of the malleability of any institutional setting. When observing examples from abroad, the rules back home suddenly appear arbitrary, unhelpful or plain senseless. Considering adopting foreign practices helps the renegotiation of established practices and treating them as fluid.

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Institutions and externalities. Implications for land management

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Abstract
This chapter will critically review the concept of institutions and externalities. We will highlight the three pillars of institutions and define the three main classes. Regarding externalities, we will emphasise the normative character in many cases where planners consider public intervention is justified on scientific or positive grounds. We will also discuss specific cases where high transactions costs lead to relevant externalities that might justify public intervention. In the final section, we will briefly explore some implications of these results for land management.

Keywords: institutions, externalities, land management.

1. A definition of institutions

A definition of institutions seems to be a controversial issue. Commons (1931, p.69) already pointed out the "uncertainty of meaning of the word institution." Commons argues that sometimes the concept of institution appears to refer to the behaviour of individuals and other times to "structure" (the body of regulations or laws). Although many attempts have been made to define institutions, some uncertainty remains regarding the meaning. For example, one of the most prominent scholars in the realm of institutional economics, Geoffrey Hodgson, wrote an article called "What are institutions?" (Hodgson, 2006). Readers who expect to find an answer to the question will be quickly disappointed. Hodgson uses an unbelievable number of intertwined concepts to define institutions as conventions, rules, norms, constraints, laws, beliefs, habits, customs, organizations, values, etc. (and this number is doubled by the addition of adjectives such as formal or informal to each definition). The logic of his definition of institution thus becomes chaotic and confusing. In the first instance, Hodgson defines institutions as rules. He then defines rules as customs (rules must be customary to become institutions) and then defines custom as habit (customs are shared habits of thought), and finally he defines habit within the broad concept of "psychological mechanism." However, what is a "psychological mechanism?" Hodgson considers that as institutions are psychological mechanisms, they must be in the mind. However, he then explains on the same page that rules are followed because they are normative beliefs (i.e. they are in the mind), but some rules are also followed because they are convenient, and therefore they do not need to be in the mind. At this point (almost the end of the paper), the reader neither knows what institutions are, nor where they occur. Hodgson's article, however, provides a couple of characteristics that seem to be inherent to almost all attempts carried out to define institutions. First, institutions are defined by most institutionalists not in terms of what they are, but rather in terms of what they do. Second, Hodgson's definition of institutions seems to be trapped by the structure-behaviour (or agency) duality mentioned by Commons. To overcome this duality, Hodgson finally relies on a psychological or mental explanation of institutions. This makes the concept of institutions both incomprehensible and of little use.

The alternation between structure and behaviour is seen throughout most of the relevant literature on institutions. Some institutionalists seem to understand institutions as structure, i.e. that they exist objectively and they have some type of physical appearance, whereas other scholars emphasize the meaning of institutions as an internalized but shared pattern of behaviour. As an example of the first category, we cite North (1990) and his definitions of institutions as the "rules of the game," i.e. as constraints that restrain behaviour. Many institutionalists have understood institutions as inalterable structures (similar to North's metaphor that defines institutions as "jails" or that used by Commons, which defines institutions as "buildings"), rather than as modifiable structures according to different purposes (Sewell Jr, 1992; Hirsch and Lounsbury, 1997). In this respect, institutions are conceived as invariable and permanent. Accordingly, institutionalists who tend to equate institutions with stability or durability have developed various explanations for reluctance to change (Clemens and Cook, 1999; Dacin et al., 2002; Sorensen, 2011). Institutions become institutions because of their invariability over time, because institutions are, by definition, "the more enduring features of social life" (Giddens, 1984, p.24). Explaining institutions seems therefore equivalent to explaining their durability and persistence (Hodgson, 2006). However, we observe that in the real world, institutions are continuously developing, i.e. institutions change. By describing institutions as endurable, we are not describing anything real.

As mentioned above, other institutionalists go further and consider institutions as internalized patterned behaviours. Institutions emerge after repeated behaviour under certain circumstances. Institutions can be called institutions if they are internalized in the mind. Note that this is also the second step in Hodgson's definition of institutions (from "rules" to "habits"). For these institutionalists, institutions are rules that bind expectations, as in the case of reciprocity rules (Ostrom, 1998), where people act according to the expectations of others. The same occurs when people act following what has been called "a logic of appropriateness." In this case, people behave in different situations in the way that is most socially appropriate (March and Olsen, 1989; Olsen, 2009). In both cases, people's behaviour is defined by society, to the extent that it shapes bound expectations in all members. Another interesting aspect is that, for these institutionalists, institutions seem to emerge as products of self-organization. It does not matter whether we refer to institutions as property rights, as in the case of Demsetz (1967), or as "reciprocity rules," as in Ostrom (1998). This concept of institutions seems very narrow and does not describe all types of institutions that are found in the real world. For instance, many of the most important institutions are explicitly designed and are far from being a product of self-organization processes.

Other institutionalists go even further and consider institutions to be generated by interactions among people, as a sort of mental script: note that this follows Hodgson's outline for defining institutions, as mental script is what Hodgson meant by the concept of "psychological mechanism." Mental scripts are culturally embedded in the minds of people (Gioia and Poole, 1984; Lord and Kernan, 1987; Johnson et al., 2000). In this case, human action is based on mental scripts that give people the correct (from a social point of view) choice for each situation. The idea that mind plays a key role in action is also expressed by the old institutionalists. For instance, Veblen (1919: p. 239) defines institutions as "settled habits of thought," which in the end are an "outgrowth of habit." The idea that institutions are the result of mental states, or are at least products of mental processes, has also recently been used by North (2005) in the concept of "mental models." That institutions are somehow embedded in the mind ensures certain patterns of behaviour. Hodgson (2006: p. 6) even argues that if institutions do not shape a certain type of behaviour, they cannot be considered institutions. This is what makes institutions what they are. There can be a "structure," there can be "reciprocity rules," but if these are not present in the mind, they will not shape behaviour, and therefore cannot be called institutions. However, if we consider that many institutions are almost immediately followed, particularly when they are secured by fiat and legally enforced (such as the declaration of a Natural Park, the smoking ban in public spaces, or placing speed limits on roads: Hall and Thelen, 2009; Bromley, 2006), then what is the role played by the beliefs, mental scripts or mental models in these cases? Taking all this into consideration, the question is then whether institutional explanations need to rely on the mind to explain behaviour. People can have certain beliefs but not necessarily act according to them (Veblen, 1919), but the opposite is also true. People can follow a repeated behaviour without having explicit beliefs, mental scripts or models that induce that behaviour.

In summary, for institutionalists who consider institutions as restraints, institutions seem to be external to individuals and imposed to them from outside. For institutionalists who consider institutions as created from interactions among players, institutions seem to be the rules by which these interactions materialize. For institutionalists who understand behaviour as motivated by mental scripts, institutions seem to be located in the minds of individuals. In this way, a holistic definition of institutions seems to link rules, mind and behaviour. Scott (1995: p. 51) considers three pillars of institutions (regulative, normative and cultural-cognitive systems) and conceives that these form a continuum moving "from the conscious to the unconscious, from the legally enforced to the taken for granted."

Although this is a good description, it is difficult to understand how institutions work, for several reasons. How these concepts (mind, behaviour and rules) are linked is confusing and problematic. There are two main problems with this: 1) If an institution that is in the mind shapes behaviour and is considered a rule for many but not all players, how many individuals need to follow the rule for it to be considered an institution? To state that an institution only exists for those individuals who follow the rule is misleading. Although many individuals might not follow a rule, we do not stop talking about the institution in these cases; 2) People often do not have any mental script but follow the rules anyway, even though there would be substantial net advantages to transgression and to breaking them, and they are clearly against them. To explain why these rules are followed, we must to go back to Wittgenstein. Wittgenstein (1953) argues that many behaviours are not based on reasons but involve blindly obeying rules. The example of how children learn the rules of language argues in favour of this.

The second case mentioned above is the most interesting for public policy. Norms that restrict the behaviour of some individuals in contexts where there are perceived net advantages to transgression, are those that require the most policing. Almost inconceivable, these norms have been relatively neglected by institutionalists. A definition of institution that is interesting from the viewpoint of public policy is that proposed by Commons (1931): "Institution...is collective action in control, liberation and expansion of individual action." Bromley (2006) defines "collective action" as actions carried out by public bodies like parliaments or courts to expand and control individual action. This definition of institutions is very useful for two main reasons: 1) it represents the common ground of all definitions of institutions explained above; and 2) in this definition institutions are basically "actions," and they are neither structures nor mental scripts.

In this reasoning we do not need to rely on qualities of mind to explain the behaviour of the regional government or of the municipalities. Obviously, institutions are enforced in the sense that if behaviour is not in compliance with the institutions, the courts can act. In all legal systems, as Redmond (2005) points out, detection and punishment of law breakers is costly, so it is in the interest of law-makers to promote a "meta-law" of the following sort: "one should obey the laws." However, the meta-law, as Redmond (2005) points out, "is effective only in so far as it is credible" and "credibility is a function of perception of the legitimacy of the process under which the law arose and the rightful authority of the lawmaker." Weber (1968: p. 36) suggests that legitimacy is based on an authority "which is held to be legitimated and therefore meets compliance." In this way, compliance with institutions does not have anything to do with mental internalization of the institution, rather it entails how powerful or powerless the public body is to 1) become credible when undertaking collective actions and 2) be legitimated to enforce the actions. Obviously 1) and 2) are interrelated.

Bromley (2006) considers three classes of institutions: 1) norms and conventions, which are accepted regularities in behaviour that bring order and predictability; 2) working rules, which formally understood are rules that carry the expectation of a legal sanction, and 3) property relations, which concern the ownership of particular valuable objects or circumstances. The norms and conventions can be embodied in what Scott (1995) calls the cultural or cognitive pillar of institutions, while working rules are more consistent with the regulative pillar and property relations with the normative pillar of institutions.

Following on from this clarification of the meaning of institutions, in the next section we will explore the reasons why societies develop institutions to manage land.

2. The concept of externalities

Why do societies implement land policies? A number of arguments have been put forward in the literature, ranging from economic concepts based on market failure and the problem of negative externalities, to arguments based on distributional problems (Klosterman, 1985). In this section we will focus on the concept of externalities, for even today a great number of land management policies draw on this concept.

The classical theoretical background of externalities is mainly provided by Pigou and Coase. These scholars have had a considerable influence on how planning is understood and interpreted nowadays. In his work "The economics of Welfare," Pigou (1920) suggested that the free play of self-interest in markets does not always lead to allocative efficiency of resources, and, therefore, government intervention is required. Allocative efficiency of resources refers to a situation where in a market organization that is not Pareto efficient, a certain change in allocation of goods may result in some individual becoming better off, with no individuals becoming worse off. It is commonly accepted that outcomes that are not Pareto efficient are to be avoided, and therefore Pareto efficiency has been an important criterion for evaluating economic systems and public policies.

In the Pigovian approach, market intervention is justified when external effects move from the optimal Pareto-equilibrium to an inefficient state. However, nothing is said about the nature of these external effects. The Coasian approach goes further and understands externalities as a manifestation of the high costs of transacting over property rights. Coase (1960) suggests that it is a legal decision as to whether or not a harmful effect is an externality, and according to these authors, the decision should be based on a cost-benefit analysis. The Coasian approach and Transaction Costs Theory based on property rights have been quite influential in recent times in trying to explain what kind of institutional arrangements in land management can best reduce transaction costs (Alexander, 2001; Buitelaar, 2007; Musole, 2009).

2.1. The four features of the classical concept of externalities

If societies develop and implement land management tools with the aim of tackling externalities, it seems quite obvious that, in order to better understand why societies adopt new land management tools, we should first answer what externalities are, where they come from and how they are defined and formalized by societies.

Externalities arise in the work of Pigou (1920) to explain how a market transaction can be optimal at the individual level, but not at the social level. This occurs because externalities are indirect effects of consumption or productive activity which do not work through the price system. In other words, externalities have effects on the utility function of third parties (Laffont, 1989; Bator, 1958; Buchanan and Stubblebine, 1962). The existence of externalities relies, therefore, on the inability of price system to account for all costs involved in private market transactions. Externalities are thus the by-products of market activity, and we become aware about them only when third parties are taken into consideration. As a consequence of this, externalities cause inefficiencies (resources are not allocated efficiently) and thus markets cannot attain Pareto optimality. The first characteristic of externalities is that they affect the utility functions of third parties who have not agreed about this situation and therefore are not compensated.

A second characteristic of externalities is given by Mishan (1971: p.2) who argues that externalities are "not a deliberate creation but an unintended or incidental by-product of some otherwise legitimate activity." In the classical example of the factory and the laundry owner, the factory does not harm the laundry owner intentionally. If the factory were polluting the air to harm the laundry owner on purpose, we could not call it an externality. Mishan illustrates this by saying that if someone gradually poisons his mother-in-law, it is affecting the productive function of the former and the consumption function of the latter. This would seem to fit the concept of externalities. However, Mishan (1969: p.343) points out that the act of poisoning does not "accord with the popular notion of an external effect," and thus externalities are unintended.

According to Coase (1960), externalities arise because of high transaction costs. However, transaction costs may be high for three main reasons in Coase's example of straying cattle that destroy crops on neighbouring land. First, because the farmer and the cattle raiser have entitlements over land secured by an inalienable rule, following the terminology used by Calabresi and Melade (1972). This rule can be a land management tool, such a zoning plan. If this plan hampers the efficient use of land, we are not talking about an externality problem, but rather about a government failure, as property rights were badly assigned by the government. However, and again drawing on the terminology of Calabresi and Melade (1972), entitlements over land can be secured by property rules. This is already the case in Coase's cattle-crop example. In this case we would face an externality if transaction costs were too high (for instance, if it is too costly to quantify the damage). Although one may wonder where the cattle raiser and the farmer obtained their property rights from if there was only a market and no government (Canterbery, 1992; McChesney, 2006), we must, in order to be logically coherent, concur with Demsetz (1967) that there is no externality in Coase's cattle-crop example. Demsetz's argument is that it is optimal, as the potential gains in solving the conflict are less than the implied costs.

The third source of high transaction costs is the lack of well-defined property rights. Furthermore, externalities are external to the market because they cannot be traded, and they cannot be traded because there are no property rights assigned to them. Thus, externalities have been defined as "a conflicting reciprocal claim over a rival undefined use," as when rights are well defined, "property rights could not be enforced without violating a pre-existing jural correlation of rights and duties" (Nicita and Rizzolli, 2006). For instance, manure is a product of cattle rearing that can often have a negative effect on the utility function of third parties. However, as Mishan (1971) suggests, these negative effects could be internalized in the economy if a market for manure comes into being. Creating a market (parties interested in buying and selling) would involve assigning property rights, as in the case of carbon emissions trading. Therefore, we can conclude that having poorly-defined property rights is a feature of externalities.

Finally, the fourth feature of externalities is that they are source of conflicts. It would be difficult to consider a nuisance as a negative externality, even when fulfilling the three features of a negative externality cited above, if nobody complains about it. The theory of externalities has always been linked to conflicts. Thus, Buchanan and Stubblebine (1962: p.373),in an attempt to rigorously define the notion of externality, argue that an externality is "potentially relevant [in terms of Pareto optimality] when it generates any desire on the part of the externally benefited to modify the behaviour of the party empowered to take action through trade, persuasion, compromise, agreement, collective action, etc." If an externality does not exert such influence it is "defined as irrelevant" (Buchanan and Stubblebine, 1962: p.374). Considering all of these features of negative externalities together, they can be defined as follows:

Negative externalities are unintended effects produced in settings of weak or undefined property rights that affect the utility functions of third parties, leading to conflicting estates of non-Pareto optimality in resource allocation.

We will now focus on the conflictive nature of externalities. Drawing on the work of Dahlman (1979), conflicting states in resource allocation may find themselves in four situations, as in Table 1.

Table 1. Scenarios in conflicts related to externalities

		Correct	Incorrect
Conflicts	Reduced	I	III
	Endured	II	IV

In case I, the harmed party correctly anticipates the costs of bargaining to be low enough to gain from eliminating the conflict, and the externality becomes internalized by the emitter. In case II, the harmed party correctly anticipates the costs of eliminating the conflict and does not act, having the externality internalized by those affected. There is no problem with lack of optimality. In case III, the harmed party decides to carry out, in the terminology of John Commons, managerial bargaining, but finds, during the process of bargaining and policing, that the arrangement costs too much to do so. In case IV, the harmed party decides to live with the conflict in the mistaken belief that it would cost too much to eliminate it, although in fact, the harmed party would have gained from eliminating it in view of the costs with the emitter.

Dahlman (1979) argues that case I and II are not Pareto-relevant, externality remaining. In case II there are obviously no Pareto-relevant side effects remaining. Case III is not Pareto-relevant, and it does not matter whether or not the conflict endures, as the harmed party realizes that the costs of making and implementing any measure are too high. In case IV the harmed party should have bargained for abatement of the conflict but failed to do so. In case IV, Dahlman (1979: p.150) would argue that from the point of view of the harmed party, it does not appear to be a mistake to endure the conflict, because

"[G]iven the information that he has at his disposal, he performs his constrained optimization and does nothing. His information is incomplete or wrong, so he makes the wrong decision: given the correct information there is a loss of income and the situation looks very much like what we associate with an externality. Yet that interpretation is fundamentally incorrect [...]. This can be regarded as an externality only if you assume that he should have known better or that there is someone else who does know better."

Since the early theoretical debates around externalities, some authors have argued that the real problem of externalities is that Pareto-optimality exists and it is a desirable goal and externalities move markets further away from the Pareto-optimality. However, it is not possible to define how far we are from the Pareto-optimality, if there is any distance. A classical definition of externalities is not suitable for explaining the array of conflicts that many land management tools aim to resolve. This challenges the traditional justification of planning as a collective action that deals primarily with externalities and social good. The theoretical body around externalities is confusing and lacks logical consistency (Cheung, 1970; Randall, 1983).

The problem with the definition of externalities is important because economists and political scientists refuse to accept that if markets do not work as they are supposed to, maximizing the utility function of rational individuals, then there must be a kind of "dark matter," external to the market (i.e. externalities) that makes markets work inefficiently. However, the problem of externalities is a political discussion about who must bear the costs of the running of markets.

Pareto-optimality seems to be the main interest of economists when analysing externalities. This "devotion to Pareto optimality," as Bromley (1982) points out, is based on the widespread belief that economic efficiency is the only matter on which economists can pass scientific judgements. Furthermore, this idea has also been accepted by planners in order to gain legitimacy in an attempt to influence decision-making.

However, this should not prevent planners from becoming involved in understanding these issues. As noted above, in scenario IV we do not know whether the harmed party is making the correct decision. The lack of accurate information prevents players from carrying out economic transactions. This has already been noted by other scholars, who define transaction costs as "the costs that are incurred to increase the information available to us and to reduce uncertainty" (Buitelaar, 2004). Needham (2006), referring to transaction costs, states that land management reduces uncertainty about the economic context for investment decision. The transaction costs associated with the lack of information (which types of land use are permitted and which are not) can prevent people from making investments in land. By trying to generate more reliable information and knowledge, the role of planners is key to improving the decision-making process.

In the next section we will briefly discuss the role of institutions and externalities in land management.

3. Implications for land management

Drawing on the three classes of institutions mentioned in the first section, we define land management as a set of two dominant institutional arrangements for altering (managing) land property: private legal rules and public legal rules. Private law defines the rights and duties of individuals and private entities as they relate to one another. Private legal rules concerned with property are what are referred to as property relations in Section 1. All rules under private law that regulate the transfer of land (such as land market rules, pre-emption rights, inheritance rules, etc.) influence the use of land and are therefore land management tools. Public legal rules establish the powers and responsibilities of governments and define the rights and duties of individuals in relation to governments. All rules under public law that regulate rights and duties in relation to government, such as a land use plan, property tax, or compulsory purchase, are public actions that influence individual decisions about land use.

It is not our intention here to propose a taxonomy of land management tools. We merely want to emphasize the fact that land management is the result of the complex interplay between public and private law. For land management purposes, the use that individuals make of their land in compliance with public legal regulations, as well as the price at which they can sell or buy it, which is the result of combining public and private law regulations, is particularly important.

The rules for managing land will always restrict the behaviour of some citizens and expand the liberty of other citizens. This is clear in the tools of public law, such as a land use plan. However, it is also clear in the tools of private law, such as inheritance rules. Hence, why are externalities relevant to understanding the working of institutions when managing land property? In Section 2 we showed that all scenarios (except IV, if we assume that someone will know better) are not caused by Pareto-relevant externalities. However, many land management tools are not used to tackle externalities in these scenarios. Rather they are used to prevent these conflictive scenarios from occurring. This is not done on the basis of externalities, whose presence in the scenarios cannot analytically prove that this implies welfare problems, but by preventing conflicts. The way that land management tools prevent these conflicts occurring has in most cases a normative and political nature and has little to do with a scientific justification of planning.

We now focus on scenario IV of Section 2. As explained above, in all scenarios the alleged externalities arise as a symptom of high transaction costs. In a world of zero transaction costs, these alleged externalities would disappear. We showed that in the first three scenarios externalities are not Pareto-relevant. Whatever it is done in those scenarios is optimum, but scenario IV is not, and the role of transactions costs might be hampering a better outcome. We do not want to discuss here whether the government or the market who should know better in that scenario. We only want to highlight that societies develop a set of tools that provide information and security to market actors. Needham (2006) points out that a good understanding of transaction costs is very important because these costs are affected by the way in which the market in land rights is set up. Different ways of assigning land rights will lead to different transaction costs. This will affect the type of land use which people undertake, irrespective of regulation by a state agency.

Needham illustrates this with an example from a land readjustment scheme. There is an area where landownership is highly fragmented. The capital value of that area is M. If the land plots were readjusted to promote a more profitable use, the value would be M + N. Why do the landowners not achieve an agreement to initiate a land readjustment project? Because in many cases the transaction costs are greater than N. In this scenario planners assume that a public agency should be responsible for developing the project. Note that even in this case transaction costs do not disappear. It is wrong to say that public intervention under public law reduces transactions costs, as the public agency assumes the costs.

Drawing on the same example, some observers argue that what the public law and the public administration try to resolve (an assignment of rights in land that becomes problematic when transaction costs are high) is expensive and inefficient, as it could be prevented from occurring by private legal regulations such as inheritance rules, pre-emption rights, etc. A couple of remarks can be made about this observation. First, the current situation cannot be improved by using only private law rules, as these rules can only prevent worsening of the situation. Second, the use of private law rules would require reliance on a very reliable and trustful information on landownership. Again, this is very costly.

With this last example we emphasize one of the most important roles of private law with regard to transaction costs. In the absence of actions under public law, private legal regulations would still have a huge impact on land management. However, many of these consequences would not be possible without the existence of a state that maintains a land administration system that registers the land rights (types of tenure, mortgages, land uses, land values) and the bookkeeping of all land transactions that would be regulated by private law (contract law, private law or nuisance law). In this way, information provided by land administration systems reduce transactions costs for market actors (van Dijk and Kopeva, 2006; Bandeira et al., 2010) while –and this should not be forgotten— the state assumes them.

In summary, we would like to highlight that societies create institutions (public and private law regulations), implement and enforce them, either to resolve certain conflicts or to prevent them from occurring (scenarios I-II-II), but also creating public agencies that implement and enforce these institutions with the goal of assuming transactions costs and achieving desired land uses (scenario IV). In this last scenario transaction costs and the corresponding externalities seem to become important in terms of welfare.

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Territorial Justice and Equivalent Living Conditions: Insights from the New Paradigm of Territorial Development in Germany

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Abstract

The article presented in this chapter focuses on the urgency of creating sustainable communities around the world. It stretches the discourse on the need for renewed practical instruments for achieving balanced development in all countries of the world. It argues that there is a universal norm that is based on human rights, dignity and equality; and which demands equitable territorial development that caters for rural areas. It provides a theoretical background for understanding why land management is a science, an art and a practice. It also presents an orientation of the concepts of territorial justice and equivalent living conditions.

Using the example of Germany (particularly the state of Bavaria), the article shows why territorial justice and equivalent living conditions is a critical matter for regional and local governance. The German constitutional goal of equivalent living conditions and the Bavarian Concept of territorial justice enjoys a tremendous political, technical and societal attention and vital discussion in the light of increasing spatial and social disparities and the often-controversial debate of rural actors, economists and politicians on appropriate political and governmental actions. The article discusses the experience of Bavaria and Germany and lays critical foundational issues to consider to implement territorial justice and equivalent living conditions in other countries.

Keywords: Land management, rural areas, urban-rural imbalance, equivalent living conditions, territorial justice.

1. Introduction

1.1. The Contentions on the Rural and Urban Divide

Many scientists and development practitioners (including United Nations agencies) are fully convinced that urbanization is unstoppable. Their reason is that nearly 70% of the global population will be living in cities by 2050 (von Weizsäcker & Wijkman, 2018; Lu et al., 2019). Whether this forecast is correct (or not) is not important to the central theme of this article. After all, a country like Germany is a country with more than 70% urban rate, yet remains a rural country. Germany is considered rural, despite its high urbanization rate, because more than 80% of the land in the country belongs to rural areas (Magel, 2018a). How can this contradiction (high urban rate versus staying rural) be resolved? People also live in small rural towns, as well as in urbanized centers of rural areas.

Germany aside, it is essential to remember that despite the urban and rural divide around the world, within rural regions exist small towns and within rural areas exist urban centers. These places cannot be adjudged to be urban merely because of their changing lifestyles which are sometimes viewed to be urban. Change is a natural phenomenon — rural areas and rural people change too. Despite that some of these changes are adjudged to have urban character, Hardoy et al. (1992) point to the fact that these places have social networks which sometimes distinguishe them from the urban. Chigbu (2013b) carried out extensive research on this subject from an African perspective and noted that many of these small rural towns are ancestrally (kinship and family ties) connected with neighboring villages. Chigbu (2013b, p. 17) went on to show that:

“They are rural in character, smaller than urban areas and located in rural regions or territories. Their demographic trends are partly rural and urban but are neither sprawls nor fringes of a major urban area. They are usually equipped with more infrastructural facilities (schools, health, market, roads, etc.) than in interior villages. They form the centers of economic activities due to the siting of employment-generating rural industries within their boundaries. They serve as administrative centers for municipal authorities and political activities. They also have markets and availability of several services that are not available in the villages. So, it is part of the rural system but provides urban functions to the villages. In Nigeria, most of such towns develop as a result of the siting of a municipal headquarter or some other important government organization in such places. These places are capable of playing important roles in rural development.”

Chigbu's (2013b) description of these rural spaces (which are most times erroneously attributed to urban areas) clearly shows that they are not urban. Except urban areas have become only places where modern lifestyle exists, and rural areas are simply places where there is no evidence of modernity. This cannot be the case anymore because humanity is living in a world of the Anthropocene. These rural places have been referred to as rural towns or indigenous towns (see Watts, 1983; Mulongo et al., 2010). They serve as a rational spatial strategy for promoting rural development so that villages can gain access to services and infrastructure (Chigbu, 2013b). Understanding this concept of rurality is vital for grasping why a country can be adjudged urban and still be mostly rural. This is from a Global South Perspective.

In the context of the Global North, it is common that in Europe (again Germany comes to mind) the spatial structure consists of a polycentric system of large, medium and small centers which are the net or spine of these countries. In Germany, more than 50% of Bavarians (a single administrative state in Germany) live in rural areas, and about 40% of its Gross Domestic Product is generated in rural centers and regions. It would be inappropriate to call such a state, an urban state (even if it has one of the most urbanizing cities, Munich, in the country). This kind of rural identity is possible as a result of the polycentral structure and an active policy and politics (nowadays called good regional and local governance).

1.2. The concern of Achieving Rural Territorial Justice and Equivalent Living Conditions

By way of positioning, the article presented in this chapter questions the very concept of development around the world. Development cannot be about one thing. It should emphasize the very essence of human living — whether it is about territory, culture, economics, freedom, human, environmental sustainability, and the social community. It must relate to the idea of progression "from a starting point of supposed inadequacy to the fulfilment of an ideal" (Blondel & Evrard, 2019, p. 1). One of the most striking elements of "development is its element of human need" (Gough & McGregor, 2007, pp. 11-16). The "needs first" element emphasizes the importance of achieving development by tackling the multiple forms of primary or essential requirements which people must have to live in a sustainable condition. As a consequence of fulfilling these needs, it has become a global goal that all forms of challenges that deprive people of a better life should be either eradicated or at least alleviated. This is why challenges such as poverty, human rights abuse, lack of access to land and land tenure insecurity, environmental degradation, and climate change (among many others) remain issues of global concerns. In tackling these challenges, one thing all development theories and models tend to agree with is the need to ensure improvements in the living conditions of people all over the world. Development — irrespective of whether it has to happen in urban, peri-urban, rural or peri-rural areas — entails efforts put to influence the living conditions of people in an either qualitative or quantitative manner or both. The significant divergence of these theories and models have been in the "how-to" aspect of delivering development. Therefore, it can be argued that development (both as a science and practice) is primarily concerned with human well-being which can manifest in poverty improvement, sustaining wealth, expanding livelihood options, increasing socioeconomic and legal empowerment of citizens and improving the environment in which humans live, among many other objectives. Development manifests in various forms, including aspects related to spatial, humanity (including human rights and freedom), historical, social, legal, political, land and natural resource, governance, cultural, physical, economic, psychological, environmental and institutional issues. The question that has remained poorly answered (and which still arises) is: How can the current development challenges facing the world today be improved in a balanced manner?

This chapter focuses on the urgency of creating sustainable communities around the world. It stretches the discourse on the need for renewed practical instruments for achieving balanced development in all countries of the world. Therefore, the chapter argues for a universal equity norm for development through comprehensive land management and based on human rights and community dignity. It discusses a strategy which leaves no alternative but to do everything possible to ensure or pursue an equitable development throughout a country, especially the rural areas. The chapter proceeds with its argument by: first (and next), it presents the practice (including the science) of land management as a development strategy for achieving equivalent living (including working) conditions for people everywhere. Second and third, it provides theoretical and literature insights of territorial development, leading to an understanding of the essence of territorial justice and equivalent living conditions as crucial elements of rural development. Fourth, it outlines how the German experience can benefit other countries around the world, irrespective of whether they are considered to be developed or developing. Fifth (and finally), the chapter concludes with critical perspectives on the way going forward. The conclusion focuses on ways to successfully ensure territorial justice and equivalent living conditions in rural areas for the future generations.

2. (Re)Theorizing Land Management from the Lens of Territorial Development

Development can only happen in a defined domain. It happens within a domain which is either physically, spatially, socially, geographically or administratively defined. Before delving into the theoretical or conceptual understanding of land management in the context presented in this chapter, it is crucial to understand the relevance of its geographical administrative or socio-spatial applications. In spatial terms, land management applications can relate to rural or urban areas or their associated spatial relations (peri-urban or peri-rural areas). According to Woods (2009, p. 4) cited in Chigbu (2013b), "the terms 'rural' and 'urban' are very powerful words, and this is not surprising when we remember how much they seem to stand in the experience of human communities... 'Rural' has gathered the idea of a more natural way of life: of peace, innocence and simple virtue. 'Urban' has gathered the idea of an achieved center: of learning, communication, and light." As this article has a rural focus, it is essential to mention what it means. This article embraces an inclusive concept of rural. Irrespective of what it may mean to people in different places (primarily as defined by laws within specific jurisdictions around the world), there are some notable characteristics which enable people to identify rural areas irrespective of where they exist. These characteristics include traditional lifestyle, is inclined to cultural homogeneity, relatively low population, low or no industrial zones, relatively low economic activities and deviates from the key features of an urban settlement. Developing such a human settlement demands technical or scientific and practical skills in land management (as well as the art of combining these two skills).

2.1. Land Management is a Science. It is a Practice. It is also an Art

Land management, like many academic or everyday terminologies, is contentious. This is because it can mean something different to a politician (such as a politically elected individual who has a responsibility to govern a population, including the land and natural resources). It can mean something different to a farmer whose interest is to ensure consistently high yields or productivity. It can also mean something different to a surveyor in the classroom (like a professor in surveying) who may view it as a concept for modelling new approaches or ideas to be implemented by those in development practice (or development practitioners). It can also have a slightly different meaning to a practicing surveyor who may view it as a means for achieving a land-related goal or vision. It can have different connotations to people from different cultures (e.g. indigenous peoples and other traditional settlers) in both the so-called developing and developed countries. Consequently, it is not surprising that many scholars (depending on their disciplinary and ideological leanings) have defined land management in different ways. The approach of this article is to go straight into discussing its specific idea of land management rather than focus on the plethora of contestations around its general meaning.

Land management — concerning what it is, what it is not, and how it can contribute to societies all over the world — is fluid. de Vries and Chigbu (2017) considers it to be both a science and a practice. They (de Vries & Chigbu, 2017, p. 65) have rightly argued that land management "has often been primarily denominated as a collection of practices which can be described, categorized, conceptualized with some scientific concepts." Furthermore, they (de Vries & Chigbu, 2017, p. 66) noted that it is "a normative and prescriptive set of 'best' practices which have worked in one or more cases, and which, given the resemblance of other contexts, or the inertia of individual localized institutions, are assumed to work well in other contexts and circumstances as well." It is important to note that this assumption is prevalent in the manner in which land management tools are implemented around the world. Land management (as a tool for development anywhere) is highly dependent on variables of factors such as the level of capacity of those implementing it, the enabling environment for implementing it, the reliability of the land administration system available, and the policies and governance stages under which it is being implemented. Hence, it is not logical to assume that there are best practices since that would mean that there is a fit-for-all approach to its implementation. It is somewhat more logical to speak about good practices (which normatively means that what is suitable for one situation or country or region may not be suitable for others).

Land management has also mainly been defined as a practice (see Buckley, 2003; Perey & Benn, 2015). This article aligns with the view that it is more than a practice, but represents a science which is based on theories and technology both tested and untested (Hodgson, 1990; de Vries & Chigbu, 2017; Tengberg & Valencia, 2018; Chigbu, 2019a). Furthermore, this article also views land management to be much more than a science and practice. It is also an art. Land management is the science, art and practice related to the conceptualizing, designing, implementing and evaluating socio-spatial interventions with the purpose to improving the quality of life and the resilience of livelihoods of the people and their environment in a locally responsible, consensual and smart manner. Land management is a science because it is based on fundamental concepts, constructs, relations between concepts, assumed cause-effect relations, theories, methodologies, etc. It is an art because it is not based on random behaviors. It can be a habit that requires specific skills which are the personal or cultural possessions of land experts (this is especially true in customary or indigenous settings). It is a practice because it is based on implementation (intervention) procedures, norms, ethics and values towards improvements in human societies. This is what makes it possible for land management to drive territorial development and the vision of achieving equivalent living conditions.

The consequence of this tripartite nature of land management is that it "has functions that cut across multidisciplinary and multi-sector issues that are linkable to natural resource governance, policy, ownership, and use" (Chigbu, 2019a, p. 5). Land management functions include traditions and cultural values of rural and peri-rural (and not only urban or peri-urban) structures and ways of living and the arrangement of physical infrastructure and management of the rural environment, including the establishments of effective and efficient real estate market, providing natural resource information, and making appropriate development planning (Magel & Wehrmann, 2006; Chigbu, 2012; Chigbu, 2019a). Its functions also include the sustainable use of natural resources. "When well instituted (planned and implemented), land management has the potential to make rural spaces (such as villages) functional living and working places by balancing the presence of farm and non-farm activities" (Chigbu, 2019a, p. 5). For more details on the functions of land management in a rural area, see Wilson (1998), Pašakarnis and Maliene (2010), Chigbu (2012), Magel (2015-a-b), and Paul and wa Gĩthĩnji (2018). Land management presents "a long-term approach to accomplish socio-economic and ecological goals of land and its different sectors have to meet present and future human needs through the participation of different stakeholders in different country contexts" (Magel et al., 2009, p. 3). It facilitates sustainable development following good governance principles and allows stakeholders with interests in land to work together to implement the goals of land policy. It also has a territorial rural development perspective which is key to achieving equivalent living and working conditions for people.

2.2. The Rural Context of Territorial Development

The discourse concerning the best ways to achieve sustainable rural development around the world has been going on for more than seven decades. "It is a debate that has taken theoretical, ideological, conceptual and methodological angles" (Chigbu, 2019a, p. 2). Despite the varied discourses on the subject globally, territorial development and equivalent living conditions (as land management intervention to rural development) have been poorly explored. The many scholars who have written on this subject have mostly viewed it from different aspects. These perspectives can be described to include modernization (Klinghoffer, 1973), basic needs (Palmer, 1977), local government administration (Rondinelli, 1979), participation (Cohen & Uphoff, 1980) and agricultural development (Bryceson, 1999), land-use planning (Chigbu & Kalashyan, 2015; Chigbu et al., 2017). Some others have viewed it from multifaceted approaches (Phuhlisani, 2009), land tenure (Chigbu & Klaus, 2013), development policy (Alemu, 2012), village renewal or revitalization (Magel, 1996 & 2000; Wilson & Wilson, 2001; Chigbu, 2012), and cultural development (Chigbu, 2013a-b). There are others who have viewed it from the perspective of place attachment (Chigbu, 2013c), responsible land management (de Vries & Chigbu, 2017), women's empowerment (Chigbu, 2015a), ruralization (Chigbu, 2015b) and community development (Chigbu et al., 2018) (the list is innumerable). Among these scholars, Magel (2015a-b & 2017) have approached the subject from the perspective of territorial justice and equivalent living conditions. However, territorial development does not in itself mean territorial justice (Magel, 2021).

Territorial development (as a land management tool) evokes a multi-sectoral approach in rural development — an approach that embraces "the sustainable management of the rural space and its economic and social links with urban centers, as well as the decentralization process and issues of local governance" (Binder et al., 2007, p. 36). Simply put, it connotes the "overall effort to ensure equivalent conditions of life and work throughout a whole region and as a result in cities and rural areas," (Magel 2015a, p. 58). "lt is an integrative concept or notion developing all sub-units of development within the rural space - hence, the evolution of a territorial rural development approach" (de Vries & Chigbu, 2017, p. 66). In the rural context, territorial development entails a "strategy for improving rural living conditions, by wholly focusing on place-based functions and assets; in order to increase balanced distribution of resources and decrease inequality; to reduce social/cultural, economic and natural resource deprivations" (Chigbu 2013b, p. 139). Some of the preconditions for its successful execution include rural planning and visioning, improving accessibility of growth centers, citizens' participation, decentralization of responsibilities and local governance (Magel, 2015a). "ln practice, land management can enable these preconditions in order for rural development — in this case, territorial rural development — to thrive" (de Vries & Chigbu, 2017, p. 66). This explains why it is considered to be a principal responsibility for land management.

Chigbu (2013b) and Magel (2015a-b) have separately argued for the practice and science of achieving equivalent living and working conditions in rural areas through territorial development approaches. From Magel's (2015a) perspective, the objective of rural development anywhere around the world should not just be about farming or agriculture. The task of rural development must extend to all aspects of life, work, housing, leisure or communication in given rural areas (area of operations). This does not mean that farming is no more important in rural areas. Of course, there is always a need to promote farming, as well as to understand the historical evolution of utilized agricultural area in the rural development process (Rico & Crecente-Maseda, 2011). Magel's (2015a) argument is that rural development activities must extend beyond agriculture to all essential functions of human existence in rural settlements. It also means that rural municipalities should serve as critical partners for all actors implementing rural development, ensuring that it goes from sectoral-based to place-based approaches. It must also consider all cultural, socioeconomic, and historical ties to the living and working conditions of people (as well as enhancing linkages between small and medium-sized urban centers in rural areas; and together with their interrelationships with larger agglomerations. Magel (2015a-b, p. 55) has firmly argued that "if this is not done, cooperation between urban centers and rural areas; and between town and country will not work" and that "this requires a suitable spiritual cum mental conditions and fair spatial enablement of all entities."

3. Addressing Territorial (Rural) Development in the Context of Territorial Justice and Equivalent Living and Working Conditions

A historical look at the human thinking behind rural development shows that efforts have been made to outline different approaches and critical ideas in the past (Phuhlisani, 2009, p. 10). The conceptualization (and implementation) of rural development approaches have historically been associated with objectives of modernization, large-scale state involvement in the development of agricultural productivity (in the Global South), empowerment within a context of diversifying rural livelihood opportunities (everywhere), poverty eradication, and the revitalization of moribund settlements (in the Global North). Irrespective of the region of the world, rural development should be done to ensure a balanced development that reduces inter-regional disparities, and make mobility and accessibility of human needs (including materials, knowledge and opportunities) possible for all. Magel (2010) has long noted that balanced developments are achievable through planning and developments that emphasize provision and sustenance of basic human needs in a way that various regions and sectors within a country can benefit.

3.1. Territorial Justice and Equivalent Living Condition as Necessary Components of Rural Development Everywhere

Academic discourse on rural development has, to some extent, failed to unravel the complex relations concerning how specific spatial units relate to different contexts about critical territorial resources fundamental for the satisfaction of community needs. Theoretical issues around territorial development thoroughly explains this. That is, "each locality represents a unique case of intertwining economic, cultural, social, and physical resources and potentials, advantages, and disadvantages, which conditions the current state and further development of the locality" (Bučaitė-Vilkė et al., 2019, p. 128). It is for this reason that, even the implementation of territorial development approach (in itself) would not necessarily lead to territorial justice and equivalent living (and working) conditions for people in rural areas. This is why territorial justice and equivalent living conditions are both a necessity (as both processes and end goals) for development. Together, they are subjects worth diagnosing and promoting within the global paradigm of rural development. Growing spatial inequalities and the increasing lack of cohesion in many countries calls for equal spatial planning and development that caters for the simultaneous (and to an extent, equal) development of both the urban and the rural areas. Both the urban and rural areas demand justice and political wisdom in the light of a growing spatial divide.

Like social justice, territorial justice has an ethical normative background. That is the global idea of equality of all people and therefore equal human rights and human dignity. Edenhofer et al. (2010) identified three aspects of this ethical background in their book, "Global, aber gerecht: Klimawandel bekämpfen, Entwicklung ermöglichen (Global yet equitable: Combating climate change, enabling development)." Furthermore, Edenhofer et al. (2010 & 2012) identified fairness to equal opportunities, fairness to satisfying daily needs and fairness of procedures committed to the idea of human dignity and human rights. These ethical issues are the bases of the global civil and social contract of human beings (Magel, 2015a). Besides these ethical bases, there exist a lot of philosophical theories about justice. John Rawls' book, A Theory of Justice, has laid the ground for accepting the view that differences are possible in any development process but emphasized that tradeoffs should be put in place to ensure balanced development (Rawls, 1971). This means that where low and high differentials exist in the development of human settlements, compensatory measures should be put in place to support the disadvantaged areas. The works of Sandel (2010), Amartya Sen (see Sen, 2005 & 2018), Dworkin (2002) and Soja (2013) have also widened the discussion in many ways. Today, every land management expert welcomes (for example) the ideas of Sen (2005 & 2018), because without practicing these ideas no endogenous development can be achieved, and even when achieved, such development cannot be sustainable. Piketty (2015 & 2016) referred to earliest periods of the French revolution (of 1789) and later histories in the course of searching for ideas that could be used to achieve a just world and just land management. All of the scholars mentioned above have influenced the idea of territorial justice as contemporary scholars conceptualize it.

The ideas of territorial justice revolve around the adaptation of two fundamental principles of justice which can lead to a just society. These two principles entail, first, ensuring that members of society enjoy fundamental liberty that is compatible with those enjoyed by others. And second, guaranteeing that socioeconomic positions are to everyone's advantage, as well as open to all who seek it. The lack of comprehensive rural development approaches in many countries around the world, especially in countries of the Global South, means that there are several methodological challenges encountered in rural development implementation. In most countries (including countries of the Global North) rural development is not always inclusive and equitable. Adopting territorial approaches that are embedded in the principle of territorial justice provides a way forward. However, this depends on the political realities in countries; and their development policies, goals, programs, strategies, measures, institutions and governance mechanisms. Embracing territorial justice as a crucial principle can make the implementation of rural development much more transparent and suitable for monitoring the progress and for evaluating the result of having reached better equivalent living conditions (Magel, 2018a).

Local and regional disparities in the living conditions of people usually "weaken the cement that holds nation-states together" (Plümper et al., 2018, p. 309). Territorial justice presents a logical justification concerning why equivalent living conditions should be a critical objective of development models. It provides an opportunity to explain why the weak living conditions can transform to better well-beings when changes are introduced in ways that are based on principles of justice. It is essential to clarify what equivalent living conditions does not mean perfect equality in a socioeconomic sense. What it does is to provide a framework to ensure that the preferences of people and communities are tailored to their development needs. The German paradigm for equivalent living conditions provides a practical for countries who have not already embraced the practice of equivalent living conditions. It has some critical elements which other countries can adopt in their quest to promote territorial justice and equal living conditions through regional and local governance.

4. Territorial Justice and Equivalent Living Conditions— a Matter of Regional and Local Governance in Germany

When people leave the countryside and migrate to agglomeration areas, as it happens in many countries (in Germany, this is very common in the Eastern part of the country), it usually leads to an unbalanced type of development. Scholars tend to assume that the reason for this kind of rural-to-urban movement is squarely for better jobs and the supposedly wealthy life people live in the cities (Lagakos et al., 2018; Ye, 2018; Brøgger, 2019; Magel 2018b). However, other driving forces motivate this sort of migratory movement. Prevailing inefficient spatial structural conditions are mostly the cause that motivates people to migrate to more spatially connected settlement regions. The point being made here is that the so-called wealthier or better lives in cities are not causes but rather favorable consequences. From a land management lens, the lack of efficient spatial connectivity is common in rural regions. This is one of the reasons they are sometimes referred to as remote areas. This situation results in shrinking farmers, and lack of new job opportunities, among many other issues. Of course, dependence on outdated rural policies (combined with ineffective economic thinking or ideologies) exacerbates the situation. Together, all of these could be summarized in two phrases - bad governance or inefficient land Management. This is what has been identified in Germany and has occupied the attention of land management experts, planners, other land sector experts and politicians in the country. What should be done in this kind of situation? This part of the chapter neither asserts that Germany is the best example nor a perfect state of art or science or practice in territorial rural development issues. It merely presents an example of how the situation is being handled in Germany, with the hope that it provides a framework for tackling the situation in places or countries that are struggling with finding a way forward.

4.1. Even in Germany, the Rural-Urban Contention Remains

To understand the debates in Germany about the urban and rural areas, it is crucial to begin by grasping the Territorial Agenda (TA) of the European Union. Europe (EU) has long paved the way (at least, ideologically) towards achieving a balance between urban and rural areas by establishing a “balanced and polycentric urban System and a new urban-rural relationship” (see European Union, 2004 & 2011). This European spatial vision started focusing on four pillars: (1) Polycentric and balanced spatial development in the EU (also referred to as cohesion); (2) Dynamic, attractive and competitive cities and urbanized regions; (3) Indigenous development, diverse and productive rural areas; and (4), Urban-rural partnership. In the Territorial Agenda 2030, two additional pillars were added. This has made it six pillars. Looking at the current state of affairs around Europe, it may seem very difficult to achieve these ambitious goals. There are many reasons for this, including ongoing globalization and increasing competition of EU regions, structural changes, new attractive modern jobs located in the metropolitan urban centers and due to prevailing opinions of leading economists who do not see any much economic opportunities in keeping peripheral rural EU regions alive. One of the main goals of the EU is to promote the principle of cohesion. This means a decrease in economic disparities between different regions of the EU. This implicitly supports equivalent living conditions (at least in principle).

Some economists have argued against (and sometimes denied) financial supports to rural regions because they are viewed as uneconomically profitable in investments. German Economist, Joachim Ragnitz (2018) once expressed this rather dangerous sentiment very clearly by saying, "Give money to rural people to give up their rural home and move to urban centers. We should close some villages." Surprisingly, in UK people like Joachim Ragnitz are beautifully called the new urban economists. In response to Joachim Ragnitz statement, the German Minister for Spatial Development, Horst Seehofer, called Ragnitz wording irresponsible. This scenario says a lot about the debate on the rural-urban divide in Germany. The German President, Frank Walter Steinmeier (cited in Magel 2019, p. 49), has also waded in by expressing concerns about the increasing spatial divide in the country. He has noted that it will cause more and more social divide which could result in political consequences (especially a change in the electoral behavior of rural people). So, even in Germany (just as in many other countries), the rural-urban contention remains with people. One political party benefits while another party loses from it. Nevertheless, all politicians always refer to the German constitution whenever they make their arguments. This reflects the nature of the debate in Germany.

4.2. Explicitly, there is a belief in Equivalent Living Conditions for all People and Regions in Germany

The German constitution is unique. In Art. 72 (2), there is a constitutional mandate for the state to ensure equivalent living conditions throughout the

German federal territory. Furthermore, in the Federal Spatial Planning Act of Germany, the task and overall concept of spatial planning are described as "… sustainable spatial development, which will be balanced on a large scale with equivalent living conditions in all regions." In Bavaria, the German state where Crecente-Maseda (see Crecente-Maseda et al., 2018) spent a lot of his research time, there also is a regional constitution which demands for an express public vote on equivalent living (and (even working) conditions (Art. 3: 2). It is widely accepted that German citizens and regions should enjoy equivalent living conditions wherever they live (citizens) and wherever the region is situated.

However, there is always a challenge in understanding what equivalent living conditions means in Germany and how it ought to be implemented. Since nobody knows what equivalence means. Experts in spatial planning understand the technical and measurable criteria (and factors) but lack an understanding of the picture of "equivalence." The equivalence aspect is challenging because it includes intangible and emotional aspects of life. In order to truly understand and define the actual state of "equivalence" in practical terms, the Bavarian parliament decided to establish a Commission of Inquiry on "Equivalent Living conditions in whole Bavaria." Members of this Independent Commission included thirteen (13) persons. The membership included parliamentarians of all the four (4) political parties in the state and eight (8) external experts nominated by the parliament. Prof. Holger Magel (the co-author of this chapter) in his role as President of Bavarian Academy of rural areas was one of these eight (8) members. The eight (8) external experts also included four (4) members of the Bavarian Academy of rural areas who were also nominated by the parliament. That also meant that rural voices had some weight in the Commission.

Concerning the work and result of the Bavarian Commission, Magel (2018b), has written many articles in German publications to convey the specific activities undertaken. Magel (2017) has also given several presentations on this issue in China, Athens (Greece), and Krakow (Poland). In China — because China has now acknowledged that its rural challenges have caused by increasing spatial and socioeconomic imbalances. China is increasingly making commitments to improving its countryside. Why Athens and Krakow? There is either a lack of effective rural policies in Greece (nearly half of the Greek population live in Athens) or no functioning spatial planning system. In Poland, rural is still regarded as a purely agricultural issue. Similarly, the other co-author (see Chigbu, 2012, 2013a-c & 2015a-b) has done the same in the sub-Saharan region of Africa where rural areas in many countries are still viewed as inferior settlements, considered as purely agrarian, and neglected in the policy implementation frameworks in national development efforts.

In Germany, time is over for rural policies which target only agricultural issues. Only 2 per cent of employees are working as farmers. The majority of people in Bavarian villages are non-farmers, even though the state is as already mentioned mostly rural. These rural non-farmers still need new jobs outside of farming. They either access these jobs in the cities by daily commuting or new jobs are provided in the countryside through new technologies. This demands for internet access, attractive infrastructure, new mobility facilities in rural areas (to mention a few). Hence the practice of equivalent living condition in Germany (as shown in Bavaria) allows for strengthening weaker regions by improving on their priority needs (and as defined by the people). This is possible because "local governments regulate development and structure their municipal areas and space as part of their formal responsibility" (Chigbu & Kalashyan, 2015, p. 7).

4.3. Equivalent Living Conditions: A Political Will or an Ethical Must?

Based on the German experience, equivalent living conditions (for urban-rural balance) cannot only depend on political will and ideologies. Even a strong political will is needed everywhere, whether in Argentina, Brazil, China, Germany, Ghana, Greece, Namibia, Nigeria, Poland, the UK or the United States. In the land management context, it requires urban-rural land linkages—that is, a focus on how urban and rural areas are linked via land management activities (Chigbu, 2021). Such land-related relations is vital to put rural issues on top of the priority agendas and budgets for development The problem is that there is always the challenge of scarce financial resources, but leaving the rural areas behind will be a significant setback. Former French Prime Minister, Edgar Faure's (a rural politician in the times of Charles de Gaulle), warned that that "If the rural areas do not breathe any more, the urban areas and cities will suffocate." This situation is becoming more and more of a reality. The situation is additionally deepened by climate change. This means that measures that are much more than only political agendas are urgently needed in countries of the world. New and higher ideas are necessary more than ever today.

Equivalent living conditions are not a matter of mere policies only. It is much more than policies. It is a question of justice (of territorial or spatial justice). It is not only a "right to the city" (Harvey, 2003; Marcuse, 2009; Middleton, 2018). It is also about the right to rural life with modest wealth (and some equivalent, but not necessarily equal standards compared to the urban). Rural areas need development models that are fit into their socioeconomic capacities in the regional environment, landscape and infrastructural needs (among many other needs). This what evokes the need for territorial justice.

4.4. Bavarian Model of Territorial Justice: A Framework for Equivalent Living Conditions

If one looks at the routine discussions of state and research institutions about the structural situation as is in Germany (or in the state of Bavaria) one will get very intensive analyses about basic needs aspects. These seven (7) basic needs and their criteria relate to seven (7) sectors of the economy: housing, employment, supplying, traffic/mobility, education, recreation, and communication (see Figure 1).

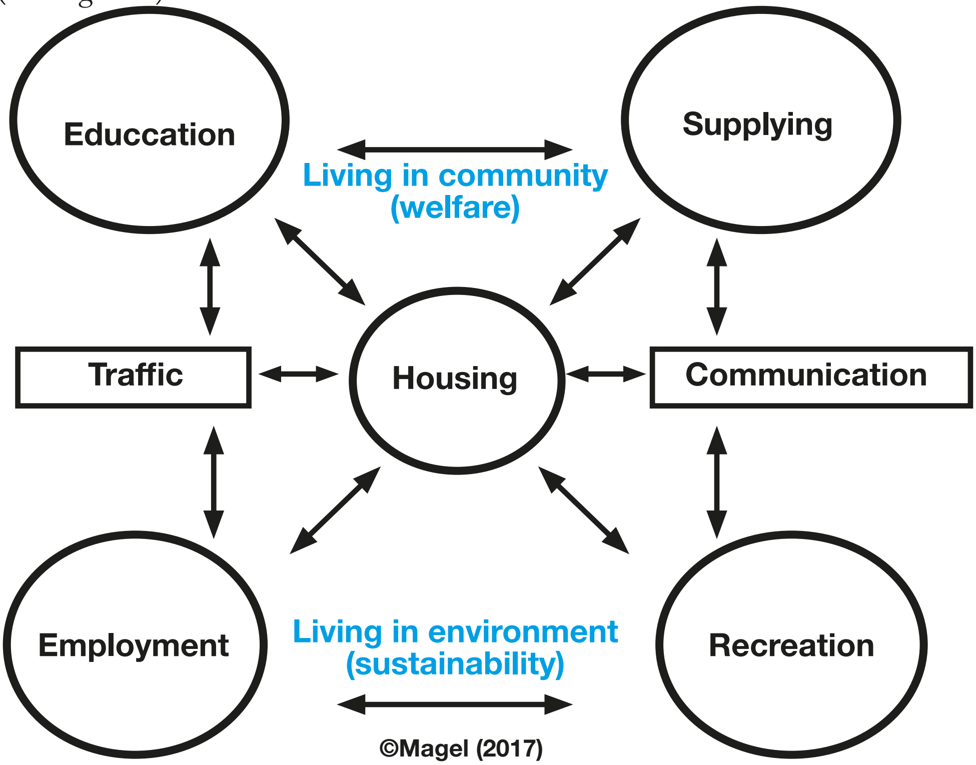

Figure 1: The ubiquitous basic needs of human existence and living conditions (Magel, 2017)

The German spatial planning community has developed many criteria that describe the fundamental needs that should be catered for to ensure equivalent living conditions. These seven (7) criteria each relate to seven sectors which politicians, NGOs, the business sector, media, and labor unions (among other stakeholders) should refer to in the course of improving human needs. While these seven issues are essential, the question that arises is, do these sectors and criteria represent and include what we understand by equivalence? Until now, nobody has done relevant research on this issue – especially as it concerns what has been discussed in the Bavarian Commission. The Bavarian Commission of Inquiry on "Equivalent Living conditions in whole Bavaria" spent much time to discuss the ideas of justice based on the universal human rights declaration and the following idea and model of territorial justice.

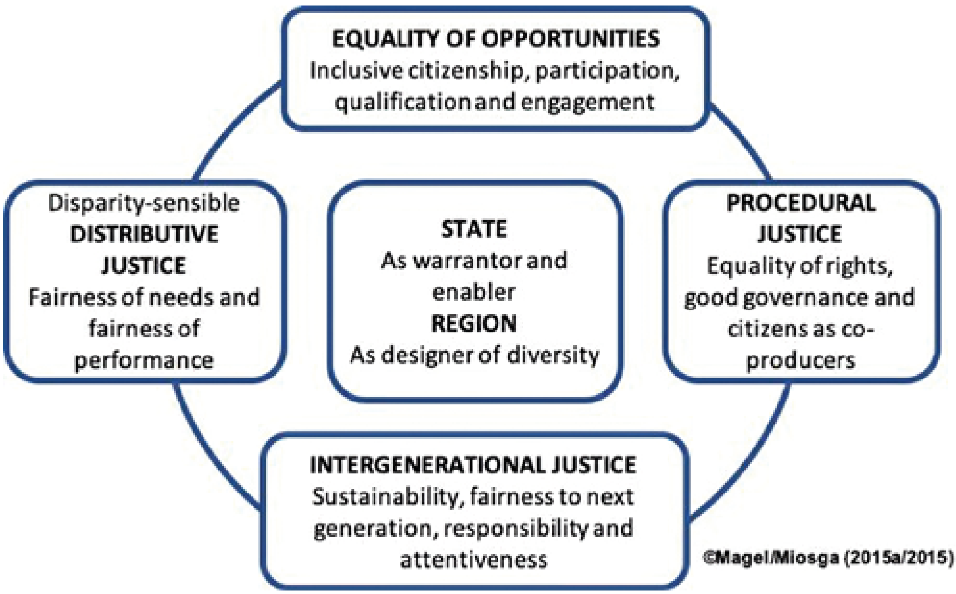

Figure 2: Model of territorial justice showing the four dimensions of territorial justice (Magel/Miosga, 2016)

Figure 2 presents the four dimensions of territorial justice which (if adapted as a framework for action by many countries) could be a neutral and transparent compass and guide for many countries. It was first developed by Magel (2015a) and amended by Manfred Miosga (2015) who was also a member of the Bavarian Commission. It represents the outcome of the discussions which involved all politicians. It led to embracing the idea of ethically based justice, thus excluding dangerous suggestions from "new urban economists" (like closing villages in rural areas). The model includes existing factors and criteria of German expertise in spatial ordering and planning but it goes much further as the model shows. It explicitly represents four dimensions of justice (like distributive justice, equality of opportunities, procedural justice and intergenerational justice). They represent the complexity of Equivalence and allow for transparently using the specific criteria for measurement, monitoring and evaluation. All of these four dimensions may never lead to equal living conditions in the literary sense of equality because differences between different regions within Germany (especially between urban and rural ones) will always exist. These differences would exist because of differences in the natural advantages or disadvantages of locations, preferences and priorities of development as conceived by differing regions (and not as a matter of utter neglect by the authorities). However, it is essential to note that if the differences are becoming too big, then the state must introduce measures to counteract it. This is possible by either making the rich regions give compensation or the state providing direct support to disadvantaged regions.

This also means that equivalent living conditions (by way of concept and practice anywhere) cannot be defined generally, but only regionally and locally. What does this mean? It means that a region could have less standard in infrastructure with better landscape and regional culture as a kind of compensation which would make up for what the region is lacking. This implies putting a sensible focus on reducing "disparities in development among regions or municipalities through the dimension of distributive justice."

For equivalent living conditions to prevail within any development domain, the policymakers must accept this idea to always ask people (in their situations) about their wishes and dreams for development (citizens participation), rather than make assumptions about people's needs as it is in the case in the conventional application of spatial planning and development. Following Amartya Sen (2005 & 2018) it is essential to focus on enabling and empowering people, thus facilitating active participation and engagement of people.

However, a critical challenge would be encountered concerning how to measuring territorial justice as a way of achieving equivalent living conditions in the context of rural development. This is important because territorial justice (and equivalent living conditions) can mean different things to different people. Hence, to measure territorial justice indicators are necessary. The measurement, evaluation and monitoring of its outcome (or success) would be difficult without having defined indicators that are measurable. Experience from the case of Bavaria shows that equivalent living conditions can be measured by measuring specific dimensions of territorial justice. Its measurement indicators embrace many indices, including economic opportunities, social cohesion, environmental state of the landscape, and health and educational services (among many other indicators). It is important to note that it cannot only be measured with good infrastructure or access to services or economic opportunities. They can be measured using travel times necessary to reach essential social services, such as health, education, and leisure services. From a spatial development perspective, the concept of central places is essential in planning to achieve equivalent living as well. Table 1 presents an example of the indicators used in Bavaria to measure the distributive justice (as a dimension of territorial justice) to ascertain the outcomes of equivalent living conditions. The measurements are done by identifying a specific domain of rural lifestyle (e.g. employment or jobs, healthcare, social justice, housing, access to social infrastructure, among others) and then subjecting them to specific indicators based on local data.

The dimensions of territorial justice	Sub-domains	Indicators	Data for measuring indicators
Distributive Justice	Employment (jobs)	Density of employees	–Employees per 1000 inhabitants who are subject to social insurance contribution in the current year
	Social justice	Citizens with minimum collateral	–The ratio of minimum collateral per 1000 citizens
	Healthcare	Provision with pharmacies	–The ratio of citizens with distances (public transfer including taxi) less than 10 minutes from the closest general practitioner (family doctor) –The ration of citizens who live 6 km away from the closest pharmacy
	Accessibility of local basic infrastructure – –	Accessibility of shopping possibilities	–The ratio of a population which live more than 1000 meters distant to the closest shop with essential daily services
		Accessibility to primary schools	–The ratio of people with public transport on the way to closest primary and secondary school split into groups of less than 10 mins, less than 20 mins, less than 30 mins and more than 30 mins
		Accessibility to a public transport system	–The ratio of citizens that live 300-500 meters and more than 500 meters distance to the closest public transport with at least five times service in both directions
	Social infrastructure	Service for seniors	–Average waiting time for a stationary place in a resting home
	Housing	Housing	–The ratio of recipients of the housing allowance in a whole population
	Security and rescue	Street crime	–Burglary cases per 1000 inhabitants

Table 1: Indicators for measuring dimensions of territorial justice (example of distributive justice) (Bayerischer Landtag, 2018; Miosga, 2018)

It is necessary that all dimensions of territorial justice be measured to understand the outcome of equivalent living conditions better. Table 1 presents an example of how a dimension of territorial justice (the example is for distributive justice) can be measured. Using specifically agreed indications (as is the case in Bavaria) can make the implementation territorial justice transparent and allow for indices for monitoring and evaluating improvements in the equivalent living conditions of a specific rural or urban area. In Bavaria, there are approved indicators for measuring all the four dimensions of territorial justice (see Miosga, 2018; Magel, 2018a). The new Territorial Agenda 2030 document of the European Union provides two priorities. These priorities include the achievement of a just and green Europe (European Commission; 2021). "Just" means achieving development everywhere, and in all places, as earlier stipulated by Magel (Magel, 2018a) and Miosga (2018) as territorial justice. In this regard, additional checks for ensuring equivalence in the living conditions of people have been included. These checks include financial situation of municipalities; economy and innovation; mobility and digital infrastructure; services for the public; engagement, social cohesion, and participation; territorial structures and housing space; and natural resources (Magel, 2021). To ensure these checks, the European Commission (2021, p. 24) called for "rural proofing." Rural proofing entails putting in place measures for assessing the anticipated impact of EU legislative initiatives on rural areas.

5. Conclusion

5.1. Rural Exodus or Rural Prosperity is No Law of Nature: It is on us to Shape the Future

"The challenge for postmodernism is that we do have accountability not only for humans who live now, even if they live far away. We are also responsible for those who are not yet born. That means for future generations (Edenhofer et al., 2010 & 2012). From a different standpoint, Randers" (2012) addressed the limits to growth in a study that somehow attempted to answer the question of how humans would adapt to the physical limitations of planet Earth. The critical inference from his proposition (and it is one that is commonsensical) is that it is on humanity (all of us) to shape the future. The current thinking – which many display consciously or unconsciously – appears to be that urbanization, rural-to-urban exodus and rural prosperity are laws of nature. Just like climate change, these challenges are created by humans and can be controlled by humans. In a country like Germany where more than 75% want to live in rural areas, it has been possible to ensure that (despite the booming urbanization) rural areas are made livable by also affording them those things which are available in urban areas. The approach of the government is best described in the following words (Magel, 2018a):

"We think about urban and rural areas together, but we do not understand them as being the same. We develop appropriate solutions for all areas, with due consideration of their respective, and very different challenges."

In order to ensure equivalent living conditions throughout the State of Bavaria (in Germany), efforts to decelerate the agglomeration areas and strengthen the rural areas have been successful but remains ongoing. This was possible by bringing jobs to the countryside by shifting university branches and state authorities from urban to rural areas and boosting the living (including working and housing) conditions of people. The problem is not yet fully resolved and remains an overwhelming one (no doubt about that). However, the approach has been to surrender to the problem by asserting that urbanization and rural issues have come to stay and should only be managed. These problems are not here as a result of the laws of nature. They are no laws of nature. It is on us — humans, especially researchers, practitioners, policymakers and politicians — to shape the future. It was us (humans) that created the problems.

Concerning how to implement territorial justice and equivalent living conditions: it depends on the country and its policies, goals, programs, strategies, measures, institutions and governance mechanisms for guaranteeing and guiding the implementation of some territorial justice. However, more research is needed to devise ways to ensure that the many countries that are facing challenges of extreme urbanization and rural problems develop workable strategies to improve their situation. This is a daunting task for scholars in rural (and urban) development and policymakers in spatial planning (development).

5.2 Knowledge adaptation and ethical norms are crucial for success

It is essential to mention that ensuring territorial justice and equivalent living conditions (as presented in this article) should be a knowledge-driven process. This is a crucial matter because what works in one country or region within a country may not work in another. Some serious challenges still exist in in the case of Germany irrespective of the attempts that have been made within the country. Despite the relative success achieved in the Bavarian region of Germany, the country is yet to achieve success. For instance, shortly after the end of the Bavarian Commission, the German government (not parliament) established a similar commission (on the same topic equivalent living conditions) at the federal level. Disappointedly, the Federal Commission focused only on technical and financial issues and did nothing about the ethical aspects of the dimensions of justice or even territorial justice. When asked why they did not dig deep into the crucial matters of territorial justice, the response was that they had no time. While this situation is unacceptable, it was understandable. The Federal Commission could not delve into the critical matters of justice because it was an "Elephant Commission" comprising hundreds of politicians and representatives of federal, regional ministries, and associations of municipalities as members. Hence, what worked in Bavaria could not work in Germany (even though Bavaria is a state of Germany). However, for the first time in Germany, regular checks of equivalence in the administrative and legislative work of all ministries have been suggested as a way to ensure success in the country. This means setting equivalent living conditions as a guideline for all states in the country. As way to ensure better living conditions for the current and future generations, the Federal Government of Germany has agreed to examine all legislative proposals to determine what effects they have on maintaining and promoting equivalent living conditions in Germany. This is called the "equivalence check;" and it demands that "all state actors bear joint responsibility for the creation of equivalent living conditions" (Deutsche Bundesregierung, 2019, p. 8). The question that arises is, how will the German government measure equivalence of living conditions, and which model and criteria will be used? It is hoped that current and future research on the development of Germany can provide answers to this question.

The lesson from the German and Bavarian situation shows that responding to rural challenges by promoting territorial justice and equivalent living conditions will pose unprecedented challenges to all countries. It is, therefore, a process that must be implemented with care and caution. The adaptation knowledge is necessary to inform policy, enhance programs, and improve knowledge capacity (including participation) for promoting territorial justice and equivalent living conditions in rural development. If territorial justice is adapted to improve the circumstances or the needs of the people (e.g., socioeconomic, cultural and geographical differences, etc.), it will make the task of achieving equivalent living conditions easier. Therefore, knowledge adaptation should target the involvement of the people within a specific territory in the effort to solve rural problems in that territory.

This article proposes that other countries that want to follow the Bavarian example must use knowledge adaptation instead of a wholesale transfer of experience. Adaptation of the Bavarian experience would require "an understanding of how the societal context of a decision process influences decisions and how people can intentionally influence that context" (Gorddard et al., 2016, p. 60). This is a critical matter because territorial justice, equivalent living conditions and territorial development in general can be constrained if the existing societal values and principles, and policies and politics (and regulations and norms) are not based on the principles of justice and equality.

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Transitions in climate adaptation: towards a steering role for the water system

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Introduction

Climate change is causing more extreme weather and problems associated with those extremes. Extreme rainfall in cities can lead to flooding, with rivers and streams suddenly overflowing. Afterwards, there might be months of drought. In the summer, the heat-island effect can lead to significantly higher temperatures. These problems are often tackled in a linear fashion. When a problem arises, a solution is developed. For example, the effects of a heavy rainstorm can be dealt with by increasing drainage capacity into the river and sea. Another example is the increasing tendency to invest in expensive air conditioning systems to cool places down. The solution is easy to work out, and its effectiveness is measurable. But if an extreme rainfall event is followed by a long period of drought, all the water that fell earlier will be needed again. Furthermore, the incidence of those types of extreme rainstorms is becoming increasingly localised and unpredictable. That makes linear solutions expensive. The same applies to air conditioning: it's expensive to operate, and it requires additional energy.

But other, more complex solutions are increasingly emerging as a way of adapting urban and rural environments to a changing climate. These solutions can include choosing a different site for a new residential block, storing water on roofs, using rainwater infiltration systems in the ground, introducing different types of vegetation, or ensuring that offices located on riverbeds place critical ICT systems on a higher floor. It's about shifting from straightforward linear solutions to complex non-linear ones. This will mean integrating water management into urban development and architecture, infrastructure, energy provision, environmental management and building management. For all these types of interventions, it's implicit that development will be partly led by the natural system. If, for example, spatial development followed that natural system, it would generate benefits in the form of cheaper, integrated solutions, and less damage to biodiversity.

Approach to climate adaptation

In practice, three broad approaches to climate adaptation have so far emerged (EEA, 2016), obviously with many hybrid forms.

— Reactive. This is a direct response to an extreme weather event. Disaster plans and heat plans are in place, in case of emergency. Emergency services are ready, the problem is solved, insurance covers the damage.
— Preventive. The preventive approach takes a somewhat longer term perspective. It often includes sectoral management plans that anticipate future problems: drain capacities are increased, dikes are strengthened.
— Transformative. The transformative approach adopts a fully long-term perspective of up to 100 years. Functional use is based on the natural system. Natural resilience is strengthened. Rivers are given more space, not just for the natural environment but also for recreation and water capture. Urban greening becomes systemic: it contributes to water capture, nature, cooling and food production.

Climate adaptation is evolving, so that rather than being about solving a clearly defined problem within a technical and often management-related sphere, it is becoming more about an integrated, transformative approach. A transition is on the horizon in which water will have a greater role in steering other development and management processes. The traditional principle that 'water level follows function' is becoming 'function follows water level'. Adaptation is being integrated into and is sometimes even a precondition for the development and management of urban and rural areas. Transformative climate adaptation demands new, more complex expertise and new policy and work processes. In other words, climate-adaptive spatial development requires a new approach. It also calls for a longer time horizon than has so far been customary: a time horizon that matches more natural processes and cycles, specifically over 100 years rather than the 20 years commonly used today. This time-frame recognises the steering role of climate adaptation, and its length gives us the frameworks and space for rolling out standard spatial development and its associated processes as we know them today. It's a new and unfamiliar way of thinking. Until now, sustainability manifested itself as an evaluation framework alongside all the others: there was no long-term vision.

The transformative approach as a whole signifies not just a different style of water management, but also a different approach to other forms of environmental management and development. This has already been noted and described by others, but observations are often rather general. We would like to explore the implications of this for professional practice within water boards. Are there case studies that could serve as inspirational examples? In particular, what does this mean for project leaders basing their projects on the transformative approach, and what can we learn from that? To address these questions, we are participating in real transformative adaptation projects (Van Rooij et al., 2021) alongside project leaders and teams. The objective is to achieve a clear insight into successful approaches to transformative adaptation, as well as less successful ones.

This article describes the initial outcomes of this process. We start by discussing the phases of transitions, and then outline some key focus areas for transformative adaptation.

The phases of transitions

Transitions in spatial development have previously been described from a range of perspectives. Loorbach (2007) identifies four phases of a transition. The pre-development phase is characterised by serious problems recognised by a limited group of people. After a period of time, these problems become more evident and ideas for solutions emerge from a larger sphere of people: this is the take-off phase. In the breakthrough phase, the issue is widely acknowledged. At a certain point the problems will be solved, structures will have been adapted and thinking will have changed. This is known as the stabilisation phase.

These phases were further developed by Loorbach whereby he differentiates between two movements that together lead to a transition (Loorbach and Oxenaar 2018). On one side there's a movement from within the existing system, whereby awareness grows that things aren't working and that constituent systems are getting stuck. At the same time, innovative practices are emerging and are developing further into viable alternatives. These two movements join up in a chaotic process. Two new movements emerge: one movement leading to new dynamic balances, and one movement in which some constituent systems are phased out.

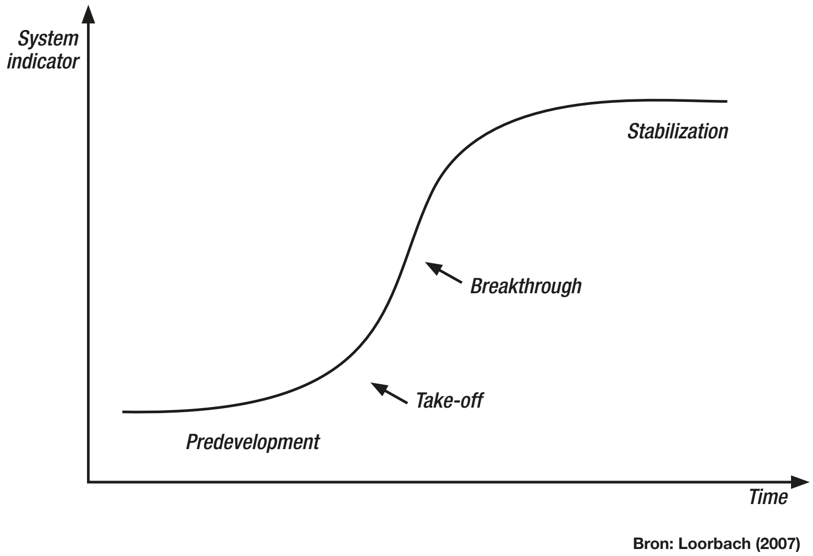

Figure 1: The phases of transitions according to Loorbach (2007).

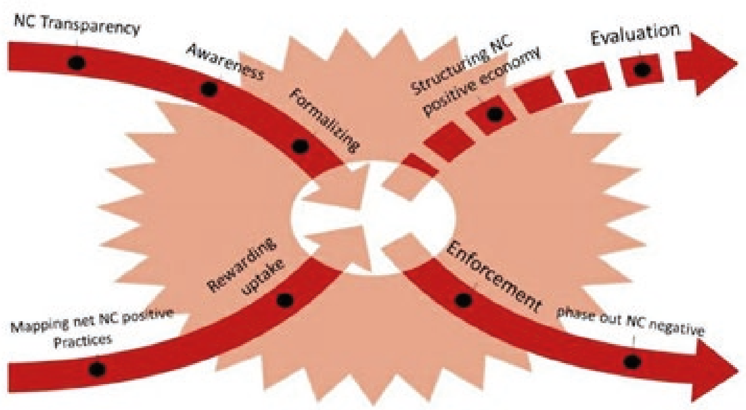

Figure 2: Transitions are built up and broken down (*Loorbach and Oxenaar., 2018*).

Geels and Schot (2007) describe transitions - in all their complexity. This multi-level approach assumes that transitions occur at three social levels. An existing socio-technical regime is embedded in society and connects a wide range of social actors (e.g. businesses, governments, users/consumers) to each other. These regimes are constantly changing in incremental ways. At a micro level, experiments are carried out and alternatives and innovations are developed. These niches are important learning spaces. At a macro level, there's the 'socio-technical landscape'. This is an 'external environment' which influences the existing socio-technical system in all manner of ways. This model is developed for (socio)technological innovations but seems also applicable to regional spatial development.

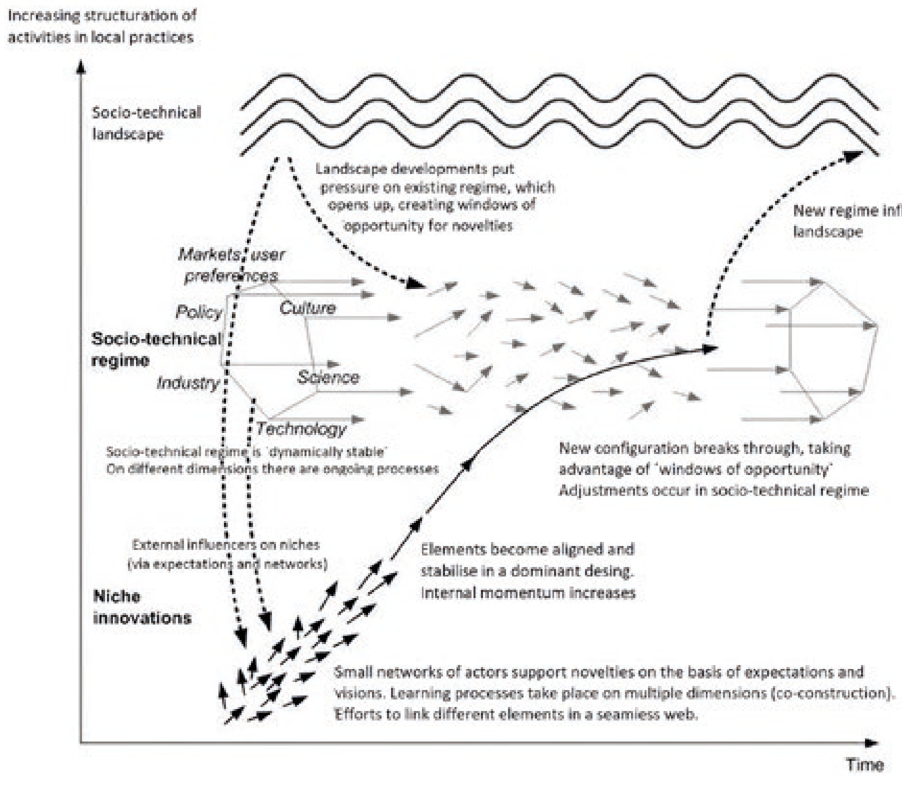

Figure 3: A socio-technical regime, influenced by experimental niches and a structuring environment (Geels and Schot, 2007)

Timmermans, Crecente and others (2013) consider this from the perspective of a key actor in a transition process, usually a project leader or director. Informal, open interviews *form the basis of a retrospective (ex-post) reconstruction for the purpose of analysing the innovative spatial development processes that emerged. This leads to the following schematic analysis of an innovative spatial development process. From the project leader's perspective, he distinguishes between seven phases, starting with a traditional approach (1). During the process, the traditional approach to dealing with water in that area comes under pressure, due to the emergence of new social problems and associated objectives. When that pressure increases, ideas emerge here and there about an alternative approach (3). If the pressure continues to grow, this leads to a discussion about a different approach (4) which is linked to a battle of directions (5). A new approach then emerges (not necessarily in linear way (6)) in which water takes on a much greater steering role with all the implications that come with it in terms of new expertise requirements, new ways of collaborating, new responsibilities and the reshaping of plans (7).*

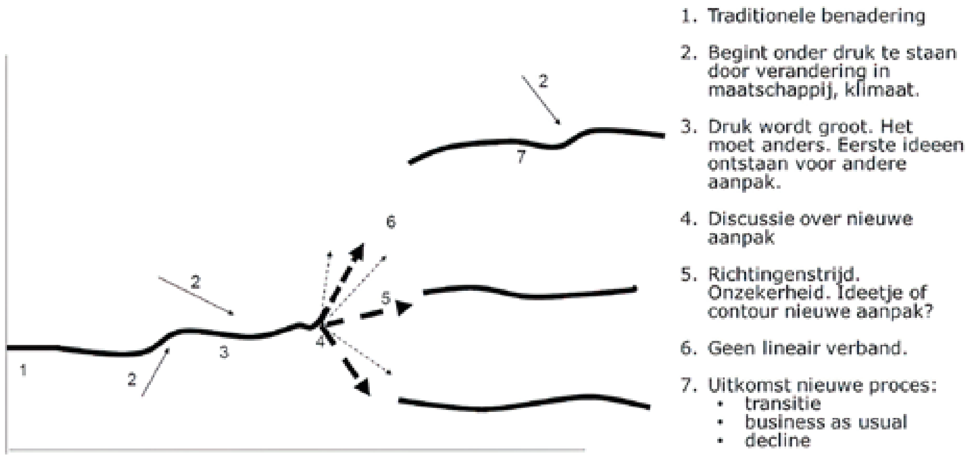

Figure 4: Schedule for evaluating innovation processes from the perspective of a project leader of a complex project (Timmermans, 2013).

The findings lead to a different picture than those described in Loorbach's transitions. A transition can lead to a new balance, but that does not necessarily signify positive progress. It can also lead to the maintenance of the status quo, or even a return to former solutions. Influence from above (the socio-technical landscape) need not be directly geographically related to the changing socio-technical regime. The sinking of an oil tanker along the coast of Galicia, or the 9/11 attacks, can influence a spatial development process from far away. Indeed, we see 'society' as being Loorbach's socio-technical landscape. Sticking with Lorenz's terminology, if the butterfly in the Amazon is big enough, it can certainly generate a storm in New York. Or in more current terms, someone in China wants to eat a bat, and the whole world is in turmoil for a year.

Transformative spatial development: three current spatial development processes

We are currently using three pilot projects to address the question of how project leaders can tackle the big challenge of transformative climate adaptation in practice. We are doing this through participative research, in which we shadow a project leader in his/her daily work and reflect on it regularly together. We're paying close attention to those aspects that are relevant to the transformative climate adaptation approach.

Case study	**Vallei and Veluwe Water Board: Regional climate adaptation plan**
Collaborating organisations	**Partners in co-creation: 26 local authorities, 2 provinces, the Water Board, North Gelderland Security Region, Vitens drinking water company, Wageningen University & Research**
Role of interviewee	**Vallei and Veluwe project leader**
In 2018, a total of 31 organisations – each with their own responsibilities – put together an atlas of climate impacts in the region, and then came up with a Climate Adaptation Strategy based on that. A Regional Adaptation Plan (RAP) has now been created, centred on the region's natural system and setting out frameworks for possible functional uses. It is based on a consortium model. The implementation programme sets out 10 points of action. WUR has been asked to work with partners in the region to establish a long-term future vision (2120) based on the capacity of the natural system. The objective is to draw attention to the long-term perspective, conceived as a dot on the horizon, while simultaneously experimenting with the implications for more immediate plans related to housing, water management and green landscape policies. The project leader (RAP) will be seconded to WUR for one day a week.	

Case study	**Rivierenland Water Board: landscape soil map in support of Environmental Policy**
Collaborating organisations	**Partners in co-creation: Rivierenland Water Board, Province of Gelderland, Wageningen University & Research**
Role of interviewee	**Rivierenland Water Board project leader**
The Rivierenland Water Board lies in the heart of the Dutch delta, between the major Rhine and Waal rivers. The Water Board is responsible for water management and acts in a monitoring and advisory capacity. WUR has previously worked with the Water Board to produce a landscape soil map, designed to make the Water Board better equipped to give input into spatial development challenges in the region from a water system perspective. The map has not yet been accepted internally. Some relevant aspects are still missing (piping and underground sandbanks/aquifers), and the Water Board is undergoing a transition from acting in a monitoring role towards having a more steering role based on the capacity of the natural system. The objective of the project is to complete the landscape soil map, linking it to new action perspectives for the Water Board, and then establish a long-term horizon vision known as Rivierenland 2120.	

Case study	**North-East Brabant, long-term vision of stream valley landscapes**
Collaborating organisations	**WUR, commissioned by the Province of North Brabant, the AA en Maas Water Board, the De Dommel Water Board in Brabant, environmental organisations, the Southern Agriculture and Horticulture Organization (ZLTO), the Midden Brabant public health service (GGD), CGM, local authorities covered by ARK Nature**
Role of interviewee	**WUR project leader**
WUR has been commissioned by the North-East Brabant stream valley landscapes working group to produce three long-term perspectives for the region. The scenarios are based on five design principles: water in balance; capturing and infiltrating water in elevated areas; moving water out of low-lying areas; mitigating extremes by creating more surface space, soil space and time; ensuring water quality. The scenarios have formed the basis for initiating action perspectives as a follow-up to the project.	

Table 1: The three pilot projects. Vallei and Veluwe, North-East Brabant, Rivierenland.

The pilots interrogate the issue of how to shape climate adaptation. Should it be a transformative approach, or will we fall back into working in familiar, linear patterns? The transformative approach is being closely monitored in the three regional processes. Initial reflections using a baseline measurement and an interview with a key person in the case study reveal six relevant areas of consideration.

Drought as a game changer

Based on other transformations from the past, it's clear that a transformation is often triggered by a transformative event that serves as a wake-up call (lit.). For many people working at Water Boards, drought would be such an event. The long periods of drought that occurred in the Netherlands in 2018, 2019 and 2020, which followed unusually heavy rainfall at the start of those years, proved to many stakeholders that there are substantial risks associated with climate change.

This led to a significant increase in acceptance of the need for a transformative approach to climate adaptation. But there is resistance too. Water Boards in the Netherlands are still heavily focused on monitoring spatial development, and their internal methods and expertise are focused on that role. They are nowhere near the point of taking a steering role at various levels of scale. Water Boards also traditionally have a hands-on culture and are focused on agriculture-related operational interventions and interests.

NL2120 opens eyes to a future vision

A true transformation usually is not clearly steered by any particular actor. There are often different people in different positions who 'sense' the challenge of change and work on it. The mobilisation of these change-makers is often a result of some substantive trigger. A good example is the NL2021 project, a long-term scenario for the Netherlands (Baptist et al., 2020), which is centred on the natural system and its capacity.

All of the project leaders who were interviewed cited NL2120 as an important vehicle for sharing their story. For many stakeholders, NL2120 made the abstract consequences of climate change more distinct and tangible. NL2120 came to be seen as a relatively unthreatening way of drawing attention to future problems, because it maps out a long-term perspective. A number of scenarios can play out within that perspective. As a whole, NL2120 has played a valuable role as a warning bell and it now acts as an overarching policy framework for many other projects, with the potential to integrate different sectors both within and beyond the spatial development sphere.

Words matter

The process of mobilisation described in the previous paragraph doesn't automatically sustain its momentum. The development of a 'language' is an important aspect of sustainable mobilisation: words that help to clarify what the issue is, and to keep ideas around it alive. In more theoretical terms: the discourse shifts, and a new discourse emerges.

Respondents commented that the way in which their projects were discussed revealed a change of discourse. Rather than it being a sectoral approach, discussions now assumed that this was a collective 'dot on the horizon' that all the various sectors could work towards, either collaboratively or individually. This was identified as the *function follows water level* argument.

Within this discourse, civil servants or project leaders fulfil an important role as translators. They see it as their job to get everyone heading in the same direction. This change is part of a gradual process and so it won't have just come out of nowhere. Efforts are being made to carefully shift the direction of the existing neo-liberal discourse by showing that the economy exists in relation to – and therefore depends on – ecological resilience, as opposed to trying to make this natural basic system fit into a pecuniary mould. Some actually called this the new Wageningen approach.

A deeper look

Transforming water management in an era of climate change requires an integrated appraisal of the social and physical system (Meadows & Wright, 2008).

This approach can be visualised as a layered model in which the bottom layer represents the slow movements of the physical system. The other layers represent, respectively, the infrastructure and the everyday use of the space. This layered approach can be translated into an action principle whereby the natural, physical system is the foundation of spatial development. This transition goes hand in hand with the shift in discourse in which people gradually move away from a sectoral approach and start to think in an integrated way, both at the managerial and implementation level.

Respondents recognise this development, and integrated thinking is a high priority for them, but they also report high levels of resistance. At a regional level, the system still seems to be organised in such a way that sectoral thinking is the dominant model.

Timing

Timing is essential in complex processes. As we said earlier, transformation is a complex process. Phases can be identified in hindsight, but at the time it's often difficult for the people involved to get a grasp of the process. In those circumstances, timing and making good use of opportunities becomes crucial.

People need to be given the full facts and context of hazards such as floods or persistent drought if you want to prompt them into making decisions. In other words, an outline of the hazard needs to include perspectives on how to prevent or resolve it. If that's missing, people tend to slip into a defensive mode and discussions can get out of hand, meaning they never get down to the essence of the issue. Social competencies are an essential part of this, along with an understanding of what drives other stakeholders. One of the respondents refers to this as 'unconscious competency'. What he's referring to is his ability to empathise with the motives of his audience while he's telling them his story. He's aware of the interests at stake in the playing field (at the local, regional, provincial and national levels) and he frames his story as a *potential* course of action based on those motives. By adopting an open and somewhat deferential stance while still speaking from a position of experience and expertise, he can persuade his stakeholders that this is their story and that it represents their interests. It's helpful to choose the right moment for this. Another respondent reports achieving broad support for her project by working tactically around regional elections and the new leadership relationships that emerge out of them.

Small wins are essential in a transformation

Small wins are modest, solid results with significant impacts (Weick, 1984). Termeer & Dewulff (2018) asserts that many transformations are down to small wins rather than major structural interventions. It's interesting to question whether this is relevant to climate adaptation as a whole. In some cases, major water works may well be needed. Even so, small wins can play an important role in getting to that point and in implementing the work.

Two respondents explicitly stated that most of the energy and action comes from lower social structures and moves up. In their experience, it was civil society initiatives and private initiatives that triggered broader action through experimentation with practical solutions. Two examples were the village communities of Winssum, where a community-based initiative is driving improvements in green landscaping, and Bunschoten, where lots of effort is being made to reduce the amount of paved surfaces.

Terrestrial turn

Lastly, we are attempting to classify in general terms the shift in thinking that is required in order to meet the challenges of the future. This change is already evident. The past few decades have been characterised by what's known as linguistic turns, in which concepts such as 'narrative' or 'framing' have played a major role (Rorty, 1967). Some have said that what we're currently seeing is a terrestrial turn (Lemmens et al., 2018). This is a change whereby the natural system becomes so important that it in fact has become an actor in its own right. This terrestrial turn is manifesting itself in many different arenas.

Some important socio-ecological events in the course of these projects include the drought challenge and the nitrogen crisis. There is currently talk of this being the 'decade of change'. Problems such as the nitrogen crisis, which was years in the making, are becoming evident and that increases the pressure for change. We now also have the corona crisis, with still unpredictable consequences such as perhaps a shift in perceptions of urgency or a new financial challenge.

Next steps

The climate challenge demands a complex adaptive transformation. The perspectives of key people in professional practice are essential to this because their actions will, to a large extent, determine the direction and pace of the transformation process. Three relevant regional processes are currently being researched, but that number will grow (Van Rooij et al., 2021). The research is drawing on techniques from anthropological literature, which means that alongside traditional governance perspectives we are facilitating additional consideration of the relevant personal interactions and cultural motivations of various organisations (Geertz, 1973).

The literature on transitions has primarily focused on understanding transition processes in and of themselves (Bosch-Olieslager et al., 2010; EEA, 2018; Rotmans, et al., 2001. This has resulted in generic insights, with a limited focus on the perspective of a project leader within a real-life transition process. We are adopting that very perspective in the context of climate adaptation, focusing on complex spatial development processes. This is delivering insights into action perspectives focused on transformative climate adaptation, which will feed into existing knowledge in the field of transition processes.

We are also drawing on new expertise. Researchers at WUR are participating actively in the transition processes, legitimised by the need for new expertise and reflections. This is based on the idea of co-creation, which means that a project leader can take on the role of reflective practitioner and the researcher can use their expertise to actively contribute to policy formation (Schön, 2010). This works differently in each spatial development process, depending on various factors such as mutual trust, process architecture and the anticipated role of expertise. Co-creation and its contribution to projects can therefore be configured in a number of different ways.

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Land Management Instruments

Land consolidation – an emotional process for the parties involved

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Abstract
Land consolidation is defined as measures that can change properties, physically or organizationally, to improve their utility to the owners. The land consolidation process can be characterized as a combination of technical, cadastral, legal, financial, economic and planning issues. Lay participants can find this process complicated and emotional, since owners have a close relationship to their properties. The land consolidation process fundamentally alters one of the most unique and complex relationships people experience in life: the relationship between a person and a social space. Strong ties to, and social relationships with, individual plots and properties are found in most cultures, and owned property is often associated with strong feelings. Consensus-building through mediation is often a better dispute resolution technique than a judicial process, and mediation can therefore be used as a conflict-reduction tool in land consolidation. The focus of this paper will be on the reduction of fragmented plots, often referred to as traditional land consolidation, involving physical changes to properties. Land consolidation is a process between neighbors. It is important to keep in mind that after the land consolidation process is finished, the parties have to deal with new properties and new neighbors, and this can be an emotional process. Based on experience of land consolidation, both in practice and from research, we will make some recommendations on how the parties' emotions and the social impacts can be taken into account in land consolidation.

Keywords: Land consolidation, fragmentation, mediation, social impacts, neighborly relations

1. Introduction to land consolidation

Parsons (1956) considered that land consolidation could be characterized as the least controversial form of land reform, although others do not consider land consolidation to fall within the category of land reform (Oldenburg 1990). Irrespective of how land consolidation is classified, it is a controversial instrument in which a public authority is in most cases able to actively intervene in the sphere of private ownership.

We define land consolidation as measures that can change properties, physically or organizationally, to improve their utility to the owners (Elvestad and Sky 2019:65). This definition of land consolidation is therefore broader than in many other countries. The measures used in land consolidation in Norway are listed in the Land Consolidation Act (Ministry of Agriculture and Food 2013). The Act comprises ten separate measures that can be used individually or together in each case. Typical examples of physical changes are modifications to properties and perpetual easements and the dissolution of joint ownership and joint use. Organizational changes are rules on joint use (shared use arrangements). The most typical example is rules on the use and maintenance of a common private road and on how the owners should deal with each other.

Land consolidation adds great value to an area, often at little cost to the landowners. Measures that are adopted are implemented as part of the land consolidation case. The measures are in some countries heavily subsidized. This includes the new roads to the parcels and, in some cases, support is also given to other types of infrastructure, such as for water, sewage and electricity (Sky 2001; Sky 2002:11).

The focus in this paper will be on the reduction of fragmented plots, often referred to as traditional land consolidation in agricultural areas (Vitikainen 2004:26). The plots are often small, and it is difficult to carry out agricultural operations efficiently. On the other hand, farmers have a close relationship with their properties and each individual plot regardless of its size. Strong feelings are often associated with one's own property, and this paper highlights the emotional aspects of land consolidation.

The process from when the application for land consolidation is made, through clarification of the situation before the case, to the conclusion of the land consolidation is often a challenging and emotional process for the parties involved. This is vividly described in Behar (1986:286 ff.) with reference to land consolidation in a small Spanish village. Reading her book and visiting the area it describes has been an inspiration for this paper.

European experts on land consolidation gathered in Germany in 1988. In a summary of key trends in European land consolidation, the need to take social impacts into account was highlighted (Läpple 1992:10). However, social impacts have received too little focus in Norway. A summary of research on the social impacts of land consolidation in Norway is presented in Elvestad and Sky (2019:71-72). Land consolidation as an emotional process will be more widely discussed later in this paper.

Land consolidation in Norway is organized in the judicial system as a specialized court. We will therefore refer to the "land consolidation court" or the "court" and the "land consolidation judge" hereafter, but this does not have any bearing on the nature of our assessments. From our point of view, the results of, and experiences from, Norwegian land consolidation are relevant in the global context even though in Norway legal terminology is used to a greater extent than in other countries.

After this introduction, with its definition and explanation of land consolidation, the rest of the paper is structured as follows. Section 2 highlights some aspects of the land consolidation proceedings and gives a description of the land consolidation process. We look more closely at the process of drafting and completing land consolidation plans. Section 3 presents the impacts of land consolidation with a particular focus on social impacts and the importance of social variables and relationships with spaces. Section 4 presents the role of mediation in the land consolidation process. Lastly, section 5 gives some final remarks and recommendations based on the findings in the presented research and our experience. We finish by raising the question: Is there knowledge about land consolidation that we have highlighted that is valuable to pass on to future generations?

2. The land consolidation process

2.1. Some aspects of land consolidation court proceedings

In Norway the Land Consolidation Act sets out who can demand that a case be brought before the court. A hearing can be requested by owners of real property, right holders and lessees. It is sufficient for one owner or right holder to apply. This is of course different in other countries. In many places a request for land consolidation must be supported by a certain percentage of the landowners concerned (determined either by land area or its possible value). The principles of simple and double majority may both be used (Van den Noort 1987). This also applies in connection with the adoption of a land consolidation plan. The majority of countries' jurisdictions stress the active participation of the parties in the initiation phase of land consolidation; see Sky (2015:85) for more details. The fact that a single owner can require land consolidation, and bring many other people involuntarily into the case, can create conflicts and generate strong emotions among the other parties involved.

Before land consolidation can proceed in Norway, three cumulative requirements have to be fulfilled: first, the land consolidation court may effectuate land consolidation if at least one property or easement in the land consolidation area is difficult to use gainfully at the current time and under the current circumstances; second, the land consolidation court may only proceed in this way in order to make the property arrangements in the land consolidation area more advantageous; and third, for any given property or easement, the land consolidation settlement shall not result in costs and other disbenefits that are greater than the advantages (Elvestad and Sky 2019:66).

It should be pointed out that these requirements apply to land consolidation in most countries (Sky 2015:87). Based on the three requirements, it is important to map out what effects each individual land consolidation case will have, both overall and for each owner. This is especially important in view of the requirement that no one shall lose out from land consolidation. This is also highlighted in Oldenburg (1990:183). The conditions should make the parties favourably inclined towards the case.

The Land Consolidation Act states that the court shall be responsible for the active management of a case and planning. The land consolidation court shall actively and systematically manage the preparation of the case, in order to ensure a quick, cost-effective and sound process. After discussion with the parties, the court shall produce a plan for the proceedings. The plan shall give the court and the parties an outline of how the case will progress, when important decisions in the case must be taken, and when the court believes that the case can be concluded. The court shall keep the parties informed of any changes to the plan. This will make the process predictable for the parties. This is important because land consolidation cases often take too long to complete.

There is also a provision about evidence. Typical evidence that is needed to clarify the situation before land consolidation is boundary markers, historical documents such as the results of, and a report from, a sub-division proceeding, a survey proceeding, a survey certificate or an old land consolidation map. The parties shall ensure that the factual basis for the case is properly and completely explained. They shall provide such accounts and present such evidence as they have. They have a duty to give testimony and provide access to evidence. Each party shall also disclose the existence of important evidence that is not in his possession and which he has no reason to believe that the other party is aware of. The land consolidation court shall present the evidence unless the parties object to this. The court is not bound by the arguments of the parties with respect to evidence. This process follows normal court procedure and means that the parties must be proactive and have a responsibility for the evidence. Since the parties often present their cases themselves, this formal procedure may be unfamiliar and can create uncertainty.

Reaching a land consolidation settlement is an iterative process in Norway and in most other countries. It starts with a draft plan after the land consolidation court has determined the existing ownership rights and easements in the land consolidation area. If the parties are in agreement on some or all of the factual basis for the land consolidation case, the land consolidation court may take this into account. Before drawing up the proposal, the court shall give the parties the opportunity to express their views. The parties shall also have the opportunity to express their views on the comments from the other parties that are made on the proposal (the adversary principle). The deadline for expressing opinions shall normally be no shorter than two weeks. The proposal shall be considered at a court hearing. If the land consolidation court believes it to be appropriate, and none of the parties object, the proposal may be considered in writing. This is one part of the land consolidation process where the parties are allowed to express their subjective opinions on their desired outcome for the land consolidation.

The process described above involves, among other things, arguing that a part of your neighbor's property should become yours after land consolidation, defending your own interests, and commenting on the valuation of the various areas including those belonging to your neighbors. This is, of course, a sensitive area and can generate strong emotions. Those working with land consolidation must be aware of this. The complete process is presented in the next section.

2.2. The land consolidation process in brief

The land consolidation process is surprisingly similar between countries, and this is something that makes knowledge of it in other countries very valuable. The process can be outlined as follows, partly after Elvestad and Sky (2019:65):

— applying for land consolidation and deciding whether land consolidation shall proceed;

— informing the cadastral authority that a land consolidation process has started;
— clarifying the boundaries and mapping of the land consolidation area;
— valuation of anything that is subject to the exchange;
— preparation of a draft consolidation plan after input from the parties involved;
— presentation of the plan to the parties for discussion;
— comments from the parties;
— alterations on the basis of comments on the plan the land consolidation court deems right and proper;
— making sure that all necessary official permits are in place before the adoption of the land consolidation solution (plan);
— formal adoption of the plan;
— marking out all new boundaries on the ground;
— formal conclusion of the land consolidation proceeding;
— when the case is enforceable, the land consolidation service shall inform the cadastral authority of the outcome of land consolidation, and the outcome is recorded in the land registry.

Land consolidation is a circumstantial process. There are several reasons for this, but one of the most important ones is that the parties are protected against losses. Their properties should have at least the same value after land consolidation. Another reason is that land transactions are complicated and finally registration in the cadastre is needed.

To really understand land consolidation, you need knowledge of various topics such as land tenure, planning, land economics and surveying, in addition to land law. That makes land consolidation challenging for civil servants and for the parties involved. Our experience is that the extent to which the parties are involved varies from showing no interest to active participation. A serious problem in some cases is that few parties are involved in influencing the outcome of the case. The reason for this may be that the process is complicated.

It is not appropriate to make land consolidation a purely legal proceeding. This can lead to a much more formal process than needed. In Norway, parties are represented by lawyers in one quarter of all land consolidation cases. In the remaining cases, the parties present the case themselves before the land consolidation court. Legislators wanted this to be possible, as it makes the process far more affordable for the parties. However, the land consolidation process often involves a mix of parties representing themselves, lawyers and land consolidation officials, which results in differences in the levels of knowledge about the process and in the terminology used to present their cases. Officials therefore face a pedagogical challenge in explaining the different issues to the range of parties involved.

The land consolidation process can be characterized as a combination of technical, cadastral, legal, financial, economic and planning issues. The process often involves different authorities such as the municipalities, cadastral service, road authorities, and environmental authorities, etc. Lay participants may find this process complicated, and it is difficult to get involved. The process can last for several years. This causes uncertainty for the parties over a long period of time. They will ask themselves questions like: Which plots will the neighbor take over? Which ones will I get? To what extent will my arguments for the new layout of plots be accepted by the others? All in all, this is an emotional process for the parties involved. It is common to find that once land consolidation has been initiated, landowners are forced to participate whether or not they want to. Hence, there are potentially high social impacts that can affect neighborly relations, both positively and negatively. Below, we will take a closer look at land consolidation with respect to neighborly relations.

2.3. Land consolidation and neighborly relations

Land consolidation is, to a large extent, about neighborly relations. A new layout of plots results in a change of neighbors and in potentially close relationships. This is illustrated in Figure 1. Take, for example, **J** after land consolidation. Before land consolidation the displayed section was owned by **f**, **i**, **l**, **m**, and **y** in an intricate, but well-functioning, system. The owners had to cooperate extensively on the utilization of the properties. Access to the properties often had to take place at certain times of the year to take into account the crop on the neighboring property. After land consolidation, **J** has common borders only with **G** and **M**.

Another example is dissolution of joint ownership. This also means dissolving a community and establishing new neighborly relations. Before land consolidation (division of the common property), the co-owners had a share and could utilize the property according to their proportions. After land consolidation, each of the parties acquired their own property. This is illustrated in Figure 2. The land tenure situation was rather complicated before land consolidation. One parcel (no. 26) was owned jointly by **b**, **d**, **e**, and **f**, other parcels (nos 28 and 29) only by **b** and **e** and yet others (nos 21, 22 and 23) by **d** and **f**. **B** is the owner after land consolidation.

Figure 1: Capital letters show the situation after land consolidation and lower case letters before land consolidation. Section of land consolidation map covering Loen in the municipality of Stryn in Sogn and Fjordane county from 1896. Land consolidation court archive, county: XII map no.: 765. Map drawn by Erik Bisgaard Falck.

Although the examples in figures 1 and 2 are from old cases, the same principles apply today.

Figure 2: Section of land consolidation map from the outfield of Upper Boge in the municipality of Fusa, Hordaland County from 1968. Capital letters show the situation after land consolidation and lower case letters before land consolidation. Land consolidation court archive, county: XI map no.: 3722. Map drawn by Kåre Riisnes.

The last example is illustrated in Figure 3. New layouts of properties often include new private roads in the land consolidation area. As a consequence, rules on how maintenance should be distributed between the owners, etc. are determined. This is important since this can cause problems between right holders in the future. In this particular case it was necessary to divide the maintenance of the road into five different zones to solve the owners' problems.

Figure 3: Joint road ("vei" in Norwegian) divided into 5 zones with separate provisions for each zone. Section of land consolidation map from Vatland in the municipality of Strand, County of Rogaland. Land consolidation court of appeal case: 2500-2009-0007. Map drawn by Cathrine Liss Hoddevik.

Another aspect which is not particularly widely discussed in the literature is leased farmland and land consolidation (Elvestad and Sky 2020). Leasing farmland is increasingly common in many countries. Active farmers need more land, because technological and market forces are pushing towards fewer, bigger and more efficient farms. This is a global phenomenon. To get access to more land, farmers lease land, but it is random whom they lease from. That often leads to fragmentation of leased farmland, raising operating costs. Land consolidation in areas with leased farmland also causes new relationships and problems that have not been previously addressed in land consolidation.

There is a tendency to highlight the importance of economic impacts of land consolidation and with good reason, because of the condition that no one shall lose out from land consolidation. The parties, however, still need to relate to each other after the land consolidation, so we must not forget that emotions and social impacts also play an important role in land consolidation.

In the next section we will present various effects of land consolidation, with a focus on social impacts and the importance of social variables and people's relationships to spaces.

3. Effects of land consolidation and the importance of social variables and relationships to spaces

3.1. Effects of land consolidation

The effects of land consolidation can be separated, at least, into economic, spatial, legal, environmental and social effects (Elvestad and Sky 2019:68 ff.). Each of these effects has an impact on the individual owner. Some owners will emphasize the economic aspect most, others the social one, and so on. There are fluid boundaries between the different effects of land consolidation, and they can affect each other. Since no-one should lose out due to land consolidation, one could say that the economic impacts have the highest importance. Goodale and Sky (1999) argued that land consolidation procedures have focused too heavily on economic variables. The other types of effects will, however, still influence whether land consolidation should proceed and affect the final outcome.

Bjørnstad (2018:72) interviewed land consolidation judges about the distribution of the impacts of land consolidation. He found that there is a tendency for applicants, since they describe the impractical property arrangements initially, to gain most benefit from land consolidation. What characterizes the people who apply for land consolidation is that they have a property arrangement that they want to improve. If this problem is not discussed with their neighbors, the land consolidation will come as a surprise. Recall that it is enough for one owner to apply for land consolidation in Norway. Since land consolidation in Norway is organized totally within the judicial system, it can be a very emotional moment when you are asked to attend a land consolidation court case. This raises questions such as: What will the applicant achieve? What part of my property will be the neighbor's after land consolidation? Will I get a new neighbor after land consolidation?

We define social impacts as how land consolidation affects individuals and the relationships between people. The social impacts of land consolidation are discussed, amongst other places, in Van Huylenbroeck et al. (1996:299), Goodale and Sky (1999), Coelho et al. (2001), Crecente et al. (2002:142–143) and Luo and Timothy (2017:506–507). Strong ties to, and social relationships with, individual plots are found in most cultures (Bonner 1987; Burton 1988; Behar 1986).

The land consolidation process fundamentally alters one of the most unique and complex relationships people experience in life: the relationship between a person and a social space.

In recent years, much critical scholarship in geography and related disciplines has drawn attention to the ways in which space – of which real property is an important example – mediates the creation and maintenance of individual, but more importantly, social identities. Relationships with social spaces are inevitably multi-faceted and become constitutive of, and in many ways generate, relationships between people. In many respects we can say that our relationships to spaces – such as a farm, a house, the field where we played when we were young – are inseparable from the public expression of our social beings (Goodale and Sky 1999:266). Traditionally, land consolidation processes have only to a limited degree considered these social relationships with spaces. Longitudinal studies to show the long-term effects of land consolidation on psychological wellbeing are lacking.

Behar (1986:294 ff.) gives a detailed description of what the parties felt about the exchange of plots in a Spanish Village, Santa María del Monte in León. There was a mismatch between the planners' technical view and the farmers' feelings about the old plots which they had cultivated by hand for many years. The social impacts are more difficult to measure than the economic impacts. Nevertheless, they are an important part of the outcome of land consolidation and need to be taken into consideration.

In Norway, and in many other countries, there is a trend towards people moving away from the countryside and into urban areas. The vacated properties are still owned by the original owners and often used as second homes. There is also increased leasing of farmland. These are factors that must be taken into consideration in land consolidation. The trend has gone from active farming to something completely different. The owner's relationship with the property has changed from seeing it as an agricultural enterprise to a holiday home, but the person still has a strong social relationship with the property. The property may have been owned by the family for generations. Land consolidation is no longer implemented just between people who are farming, but between a multitude of types of people. What should be emphasized most when planning the new layout of plots? Often, these developments can create tensions between the parties.

3.2. Relationships to property

People have different relationships to property. There is a functional relationship between land tenure and land use. Land tenure affects land use and vice versa. We can divide relationships to land or utility functions into four categories: (1) social relationships to land; (2) economic (business) relationships to land; (3) investment relationships to land; and (4) land used for private purposes (hunting, wildlife, leisure). These four categories need a more detailed explanation (see also Sevatdal 1990:2-3).

Social relationships to property. The typical situation here is properties that have been in the family for generations. It includes the importance of belonging to a social community both formally and informally. Formally as member in a landowners' association and informally, meeting the neighbors and discussing everyday matters. The property may have a certain sentimental value to the owners, and this determines their behavior.

Economic relationships to property. The property is a factor in a production process. Typically it is farmland used for agricultural purposes, but also other types of production processes, e.g. as raw material, storage space, a plot. The owner's behavior can be understood and interpreted within the framework of the agricultural business.

Investment relationships to property. The property is one of many potential investment objects held for making a return on investment. The owner concentrates on obtaining a yield and asset trading.

Private use relationships to property. The property is no longer a part of an agricultural enterprise, but the owner uses the property for "private use" as a recreational area, for fishing and hunting, etc. The key is that the owner's behavior in relation to the property cannot be understood in terms of financial or investment theory, but rather in terms of welfare theory or the like.

There is reason to assume that all owners have an element of all four utility functions, but in the land consolidation case, it is natural to assume that the owners will act in accordance with their dominant utility function.

An example can illustrate the challenges posed by different relationships in land consolidation cases. Absentee ownership complicates the land consolidation process and the future relationship between the parties. This is a growing trend which can be seen everywhere, and which is highly correlated with the industrialization of society. Absentee owners are not so closely tied to the local community. Often, they do not take part in joint activities, like voluntary communal work, the general social life of the village, and meetings of various owners' associations. In other words, they are more distant from the property and their relationship changes from an economic and social one to a relationship based on personal use (hunting in the autumn, using it as a holiday home, etc.). Experience from practicing as a land consolidation judge, and often as a mediator in the land consolidation court, shows that these two groups of owners (ones with an economic and ones with a private use relationship) have totally different views on the development of an area.[1] The established owners accuse the absentee owners of "betrayal;" a common sentiment directed toward the absentee owners is "you left us behind to take care of agricultural production" (Sky 2003:4). The relationship to the property affects behavior, but we must keep in mind that in practice there is no fixed relationship between category and behavior.

The size of the properties and the situation of the owners in the land consolidation area will often vary greatly. Some properties are small, others are large. Some owners are full-time farmers; others have their main income from another occupation. Some may not be active farmers but are leasing the land to others, etc. In practice, this means that the owners have different relationships to the property, they have different goals and difficulties in measuring utility on the same scale. The land consolidation court has rules on how "utility" should be considered, and the power to conduct the transactions even in the event of protests. There must be objective assessments and the land consolidation court shall value everything that is exchanged, based on its probable use. The land consolidation court shall allocate land and easements in a way that is advantageous in view of the grounds for land consolidation.

However, a potential consequence of these different motives for ownership is that it becomes increasingly difficult for the land consolidation court to find solutions that everyone thinks are worthwhile. To ensure that parties are satisfied with the outcome of the land consolidation it is important that the parties get actively involved in the case. One way to achieve this is through mediation. In the next section we will focus on mediation in land consolidation and different techniques to ensure the active participation of the parties in the land consolidation case.

4. Land consolidation and mediation

Susskind and Ozawa (1984) recognized the importance of mediation in planning. They argued that legislative and administrative procedures often fell short of pro-

1. One of the authors (Sky) has been a land consolidation judge for 16 years.

ducing wise decisions in situations with conflicting interests. When planners act as mediators, they can use their technical skill to suggest solutions that integrate different interests and facilitate effective implementation. Consensus-building through mediation is often a better dispute resolution technique than court cases (Sander and Goldberg 1994; Brett et al., 1996) and public planning procedures (Susskind and Cruikshank 1988; Forester 1989; Fulton 1989). Reasons given for this include that satisfaction often increases with the parties' control over the process and outcome, that the process is more focused on the needs and interests of the parties, and that the future relationship between the parties can be improved (Rognes and Sky 2003:968). It is important to keep in mind that the parties will live together and relate to each other after a land consolidation settlement. Since land consolidation involves solving boundary disputes and planning new property layouts, mediation is an important task for land consolidation judges.

The possibility of amicable settlement and mediation of cases at the land consolidation court is also emphasized in the Land Consolidation Act. The land consolidation court shall at each stage of the case consider whether mediation could lead to an amicable settlement. Mediation shall involve the court attempting to provide a basis for an amicable settlement, either at a court hearing or through other forms of contact with the parties. During mediation, the court shall neither hold separate meetings with each party nor receive information that cannot be communicated to all parties. The court cannot propose settlements, offer advice or express points of view that could impair confidence in the impartiality of the court.

Studies of the mediation process in land consolidation started in detail in 1997 (Rognes and Sky 1998, 2003 and 2008). Data from 727 completed land consolidation cases were analyzed. Mediation is applicable in two situations: boundary disputes that must be solved for the purposes of the land consolidation settlement and mediation regarding the land consolidation plan. The study of the Norwegian land consolidation courts confirms that mediation is an integral part of the judges' work on land-related issues.

The study found, among other things, that mediation through the presentation and continuous redrafting of land consolidation plans reduced the conflict level among the parties (Rognes and Sky 2003:973). This is also important in handling and understanding the social relationship between the parties. Rognes and Sky (2004:70) point out different mediation techniques used in land consolidation planning, some of which are presented in Table 1. Analyzing the parties' needs and relationships to their properties is one of the techniques presented in their study.

Often the parties have made vain attempts to reach an amicable solution to the conflict before it is brought to the land consolidation court. They have tried to reach a voluntary land consolidation settlement, but the transactions costs are too high. This does not prevent it from being a basis for assessing the possibility of mediation in the court. It is difficult to establish any rule about when is the best moment for mediation. Generally, the judge should wait to initiate mediation until he or she has formed a fairly clear picture of the case. Consequently, it will not normally be appropriate to enter into mediation when only one of the parties has made their case or presented their evidence. Often, the natural timing can be after all parties have submitted their statements.

The land consolidation judge's (or official's) involvement in mediation is often demanding. On the one hand, it is desirable for the judge to be reasonably proactive in order to promote a good and reasonable result. On the other hand, the judge must exercise considerable restraint, to avoid the parties feeling pressured into reaching a settlement. It is also important to be aware of the fact that in cases where the land consolidation judge is the mediator, the authority conferred by his or her judicial role will give the mediator great potential power. Often, the judge's professional expertise and knowledge of the dispute can contribute constructively to a solution. It can, depending on the circumstances, be appropriate to suggest solutions that involve conditions beyond the confines of the actual object of the dispute. Although the judge must be able to suggest solutions, it is important to avoid suggestions which can be perceived as an expression of the judge's decision in the judicial assessment of the conflict.

Rognes and Sky (2003:976) found that, in planning disputes, mediation efforts had a positive effect on the outcome. The effects of mediation on consensus-building can be seen in changes in objections to plans. In mediating planning disputes, the judge drafts an initial plan and uses the mediation process to adjust the plan to the needs of the parties. This is fairly similar to the one-text procedure for mediation. The results of the study show that the parties had significantly fewer objections to the final plan than they had to the initial plan presented.

This finding is relevant to mainstream planning and supports the use of collaborative planning (Healey 1998). Collaborative planning implies that stakeholders should be able to express their views, and that their interests should be considered when the plan is being developed. In the land consolidation courts, the mediation process ensures participation by allowing the parties to influence the plan through initial court meetings where concerns are raised, and through the iterative process whereby the plan is gradually developed. The process reduces the conflict level and number of objections to the plans (Rognes and Sky 2003:976). Mediation will therefore have a positive impact on the social effects of land consolidation.

The most widely mentioned communication tool in mediation is active listening (Vindeløv 2013:116). To be a good mediator, it is important to listen actively to the parties. Active listening is a communication technique where the point is to change the parties' conversation form from discussion and argument to dialogue and understanding. An important prerequisite for active listening is to be present and aware (Vindeløv 2013:177).

Goodale and Sky (1999:267) recognized the importance of active listening and proposed a method of qualitative research that both recognizes the social relationships to the land involved in the dispute and seeks to determine what these relationships are. One aspect of this method is that planners or mediators must interview parties on the property itself. The authors proposed that after presenting the draft plans to the parties for their comments on the economic valuations, planners should engage in qualitative research to determine the parties' social relationships to the land involved. This is crucial, because parties are often unable to fully articulate the meaning of their social relationships to the land in the sterile confines of the official session in the courtroom.

Various mediation techniques that involve the land consolidation officials entering into a dialogue with the parties involved regarding the plan are summarized in Table 1 (see Rognes and Sky 2004:71 for more techniques in general). We have classified the techniques by the extent to which they activate the parties; (+) means activation and (0) means neutral.

Techniques	Level of activation (- 0 +)
Presentation of draft land consolidation plan after input from the parties	+
Presentation of draft without input from the parties to show how land consolidation applies to the land tenure in the relevant area	0
Activating the parties by using tracing paper so they can map their suggestions	++
Analyzing the parties' needs and relationships to their properties	0
Talking with the parties in groups or alone	+
Excluding elements that will not be subject to exchange	0

Techniques	Level of activation (- 0 +)
Negotiating with the owners of properties for sale in the land consolidation area	+
Consensus over progress of the planning process and preparing time schedules	+
Emphasis on information about the planning process	0
Motivating the parties to make suggestions	++
Consensus over progress of the planning process	+
Consensus over different planning methods, valuation methods, etc. (principles)	+
Arranging informal meetings with one or more parties	+

Table 1: Mediation techniques in land consolidation planning and how they activate the parties.

As can be seen from Table 1, land consolidation judges employ many different mediation techniques. They also use a variety of methods for presenting a draft land consolidation solution. Geographical information systems make it possible to present several alternative solutions. In summary, Rognes and Sky (2004:72) found that:

— there are large variations between land consolidation judges with regard to how proactive they are as mediators;
— in general, the land consolidation judges mediate more proactively, and are more solution-oriented, in land consolidation planning cases than in boundary disputes;
— in general, the land consolidation judges find cases with few parties, of low importance, with uncertainty about rights and with low levels of conflict most suitable for mediation; and
— they are concerned with behavioral aspects of mediation when asked what is important for success.

Mediation does not always lead to mediated settlements. However, even when the final verdict or final land consolidation solution had to be imposed, the mediation process had positive results. The reason may be that mediation has value in its own right, e.g. by reducing conflicts. Mediation through presenting and continuously redrafting land consolidation plans reduced the conflict level among the parties. The study also indicated that land consolidation judges (officials) were in need of mediation training. This has been followed up with intensive training in recent years.

5. Final remarks and some recommendations

Land consolidation issues have been a theme in the European Court of Human Rights, cf. Convention for the Protection of Human Rights and Fundamental Freedoms. The statement "Any land consolidation is by its nature a complex process" has been pronounced in the case of Erkner and Hofauer v. Austria and in the case of Poiss v. Austria. In some cases, there has been a violation of Article 1 of Protocol 1 – Protection of property, cf. the case of Chassagnou and others v. France. "Property" includes land, and a public authority may not expropriate your property, or place restrictions on its use, without very good reason. The wording of the section is "Every natural or legal person is entitled to the peaceful enjoyment of his possessions. No one shall be deprived of his possessions except in the public interest and subject to the conditions provided for by law and by the general principles of international law." We believe that in the future there will be a greater tension between the parties' subjective interests in the utilization of the property and public interests. There must be a fair balance between private interests and the general interests of society as a whole.[2] Land consolidation officials have to be aware of this and of judgments from the European Court of Human Rights.

Another important development is the preparation of a legal guide on land consolidation produced by the Food and Agricultural Organization of the United Nations (FAO). It will be a useful document for countries where land consolidation is only being introduced or is in the early stage of development (FAO 2020).

Is there knowledge about land consolidation that we have highlighted that is valuable to pass on to future generations?

The traditional land consolidation process we have described is time-consuming and costly. However, from an international perspective Norwegian case handling times are relatively quick, taking an average of 2.4 years (Rognes and Sky 1998:2). This short time can be explained by the high proportion of the cases with few parties and properties involved. King and Burton (1983:494) estimated that, in general, the average case handling time for land consolidation was five years. Crecente et al. (2002:146) investigated land consolidation in Galicia and concluded by suggesting that inefficiencies could be corrected by revising pro-

2. https://www.equalityhumanrights.com/en/human-rights-act/article-1-first-protocol-protection-property cedures and simplifying and speeding up processes that are too protracted and learning from techniques applied in other European countries with similar policies. In Galicia, projects take 10 years or more.

Even though the case handling time in Norway is relatively quick, it may take several years from the start of the case to it being finalized. This period is characterized by uncertainty for the parties involved and a hiatus in investments in property. This time-consuming process has resulted in the increasing use of another measure provided for by the Land Consolidation Act. It is a measure that can change properties organizationally, to improve their utility to the owners. The land consolidation court may establish or modify rules for existing shared use arrangements, and the rules may be permanent or temporary. This type of land consolidation measure is not as comprehensive as physical rearrangements. The cases can be carried out faster and more cheaply. We think this development is needed. It is important to the parties that the land consolidation process is predictable. It is unsatisfactory for a case to last for many years with the uncertainty and emotional strain this entails. Our recommendation is to streamline and shorten the time taken by the land consolidation process.

Land consolidation is a complicated process. Officials face a pedagogical challenge in explaining the different issues to the parties, especially since the parties often represent themselves before the land consolidation authorities. Land consolidation is also an emotional process for the parties involved. As a professional it is important to bear this in mind. Analysis of the parties' relationships to their properties is of great importance. The parties have to be heavily implicated in the process; that is an important prerequisite for any land consolidation process.

It is important for the parties to feel heard during the process. Experience shows that if the parties have been given sufficient opportunity to express their feelings and needs, the likelihood that they will be satisfied afterwards increases. Getting the parties actively involved is therefore important. The final solution will have a more stable footing if the parties are involved. It is important to bear in mind that the parties must deal with the new properties and new neighbors after land consolidation. A process involving many conflicts between neighbors can lead to poor neighborly relations in the future. Using various techniques, including activation of the parties and active listening, will help reduce the conflict level and lead to more positive social impacts of land consolidation.

The Norwegian singer-songwriter Stein Torleif Bjella says: "There are only two tragedies in life: Heartbreak and land consolidation." More positive outcomes could hopefully prove him wrong. At least regarding land consolidation.

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Different dimensions of land banking as a land management tool

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Abstract
Different countries use land banks for different practical purposes, mostly to facilitate land transactions for improvement of farm structures (e.g. land consolidation schemes), for implementing public interest projects (e.g. infrastructure), or for implementing land use and environmental policies (e.g. nature protection areas). To achieve this, a land bank can have three main theoretical objectives: a) to improve land mobility and promote land markets (sales and rental), b) to guide the land market towards realizing public objectives, and c) to complement land markets.

The article is partly based on the author's contribution to a forthcoming publication "Land Banks and Land Funds in Europe - Instruments for Rural Development" (Frank van Holst, Francisco Onega Lopez, Richard Eberlin, Margret Vidar and Graham Hamley. Santiago de Compostela, forthcoming), which provides a more comprehensive overview of land banking in all its facets. This article wants to offer a limited insight into some of its features in terms of theoretical and practical approaches.

The concept of "land" has multiple dimensions and facets and each relates to the other. Land is foremost regarded as a production factor in the *physical sense* on which to grow crops, pasture livestock, grow trees, etc., but also as a place to construct buildings and infrastructure, etc. But "land" also refers to *land tenure* as an institution governed by formal or informal rules, land use is governed by different *policies, laws* govern its allocation, and land related *administrations* implement the relevant legal and policy framework. Finally, land is not only a physical entity, on which to pursue economic activities, but also an *economic good* that can be traded (land market).

With special reference to land banking, we will be looking at each of these dimensions (except land as physical entity) and their role as land management tools.

Land as an institution (land tenure): Land is at the same time a physical entity (grow crops, etc.), and an institution, whose allocation and use is governed by formal or informal rules, traditions and values (land tenure). Often these traditional values imply a very high intrinsic valuation of land as a property

but a very low valuation of its use. A land bank can bridge the difference of valuation between holding and using land.

Land as object of policy (land use and management related policy): Land is an object of different policies and can be used to implement policies. The question if land is a private/individual or a common good is mainly a policy question, the same is valid for its use (free, restricted or on command) and its transfer (voluntary or forced). Land banking can serve as an instrument to implement these policies.

Land as a legal subject (land legislation): The formal allocation of property and use of land are governed by laws defining who owns and can use it, and how it can be used. A land bank needs a legal framework that allows to exchange property and use rights while respecting universally accepted principles (e.g. VGGT, FAO 2012).

Land as a subject of administration (land administration): Ownership of land and its use is guaranteed by an administration that controls and enforces its legal basis and sanctions its misuse. A land bank represents an administrative instrument to intermediate between ownership and use and can act as a guarantor of rights.

Land as an economic factor (land market): Market theory presumes ideal conditions; however, land markets are non-perfect markets, one of the main deficiency being the lack of information of market participants. A land bank can be an instrument to overcome, among other, the information issue.

The article will conclude that depending on the objectives of a land bank, one or more of the above dimensions and perspectives become priority and influence on its main features.

Keywords: Land bank, land management, land market, land tenure, VGGT (Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security, FAO 2012), land administration, land use policy.

1. Introduction and definitions

Different countries use land banks for different practical purposes, mostly to facilitate land transactions for improvement of farm structures (e.g. land consolidation schemes), for implementing public interest projects (e.g. infrastructure), or for implementing land use and environmental policies (e.g. nature protection areas). To achieve this, a land bank can have three main theoretical objectives or approaches: a) to improve land mobility and promote land markets (sales and rental), b) to guide the land market towards realizing public objectives, and c) to complement land markets.

The article is partly based on the author's contribution to a forthcoming publication "Land Banks and Land Funds in Europe - Instruments for Rural Development" (Frank van Holst, Francisco Onega Lopez, Richard Eberlin, Margret Vidar and Graham Hamley. Santiago de Compostela, forthcoming), which provides a more comprehensive overview of land banking. This article wants to offer a limited insight into some of its features in terms of theoretical and practical approaches.

As defined in the above-mentioned forthcoming publication, a land bank is a public or public-private institution that, through an intermediate process of buying, selling or leasing of land, is trying to increase land mobility, to facilitate the rural land market in general, and to pursue public policy targets related to sustainable rural land use in particular. Throughout this article, "land banking" is referring to the activities of a land bank.

The concept of "land" has multiple dimensions and facets and each relates to the other. Land is foremost regarded as a production factor in the physical sense on which to grow crops, pasture livestock, grow trees, etc., but also as a place to construct buildings and infrastructure, etc. But "land" also refers to *land tenure as an institution* governed by formal or informal rules and depending on the land tenure system, different *policies govern its use*. Land related policies may be defined in the constitution (e.g. the right to individual property), in strategy and programming documents, and by democratic (parliament) or ad-hoc decisions (central decision-making), etc. *Land can be a legal entity* defined by laws referring to its allocation and use. Laws referring to land always relate to policies and institutions, e.g. which policy document is the basis for the laws and which institutions are responsible to implement or enforce the law. *Land can be a subject of administration* that is responsible to implement the relevant legal framework, which also provides the legal basis the institution's authority and power is based on. Finally land is not only a physical entity, on which to pursue economic activities (e.g. agriculture, forestry, construction, transport, etc.), but also an *economic good that can be traded*. With special reference to land banking, we will be looking at each of these dimensions and facets of land from different sides, from their theoretical background and practical implementation as land management tool.

In this article, we will try to provide some insights into theoretical and practical approaches referring to land and land banking, concluding that depending on the objectives of a land bank, one or more of the above dimensions and perspectives become priority and influence on its main features.

2. Land banking as an institutional process and instrument

If we look at land not from its use value in terms of production and economic return, but from its intrinsic value for an individual or for communities, we can regard it as an "institution." For the purpose of this article, an institution is a set of rules defined by societies to regulate the behaviors of individuals or communities (North, 1984). These rules are written in legal texts (e.g. constitution, laws, etc.), or in moral guidebooks (e.g. Bible, Koran, etc.), or can be orally transmitted social-ethical norms. “Land tenure” is defined as the institution (in North’s terms) that sets the rules regarding the use, control and transfer of land through formal or informal regulations, traditions and values.

While in most Western European countries, the agriculture sector had always been dominated by small-scale family farm structures to a different extent, the fragmented property structure of the transition countries of Central and Eastern Europe and Central Asia is a result of the land reforms of the 90s. In particular, in the countries where the land reform was based on restitution, land was given back to the former owners (or their heirs), without consideration if these were active or professional farmers. Many of the new owners were retired, having other professional activities or were living in cities.

For both groups it was assumed that economic and technological progress would lead to a natural concentration/growth and consolidation of farm structures. Economically not viable farms would be given up and the elder generation would hand over their farms to their successors or sell them. However, this was and is not happening to the extent expected.

One of the underlying reason for this lack of land mobility, among others, are the traditions and values that imply a high intrinsic valuation of land as a property compared to its low valuation of use (perceived economic return). For instance, land is regarded as an insurance for bad times (“you can always grow something”), as a hedge against inflation (“it will not lose its real value”), or there are expectations of future returns that are (much) higher than the present return (“investment, speculation”). In traditional societies, the land may be seen as the seat of the ancestors, and in the ex-communist transition countries, the (restituted or redistributed) land is often identified as a token of the newly gained liberties and rights, etc. (Dale & Baldwin, 2000). Therefore, as long as the intrinsic value of the land for the individual is higher than the present value, the land will not be sold or rented out, there will be no land on the market and there will be no land mobility.

Land banking from the *institutional point of view* can bridge the difference of valuation between holding and using land by transforming some of these intrinsic values into measurable values. How can we achieve this?

For example, the land bank does only trade with the use rights, but does not touch ownership rights. It is providing a guarantee that the land will be returned to the owner in the same or better state as before. The land bank can also provide a guarantee that social and cultural heritage are respected and informal rules followed by the user of the land.

As an example of this approach we can refer to the Galician Land Bank (BTG) (*https://agader.xunta.gal/es/banco-de-tierras*), founded in 2007 under the name of BanTeGal as an independent agency, and in 2011 integrated into AGADER (Galician agency for rural development).

The Galician Land Bank encourages the transfer of land from the owners to the farmers by mediating and by providing guarantees. It also offers standard contracts and referential prices. In addition, the Galician Land Bank responds to specific local characteristics and it targets particular population groups. In an overall attempt to stimulate and guide the land market it:

- focuses on mediating lease (use) rights rather than property rights;
- gives guarantees to landowners who enter their land in the land bank about their ownership;
- secures the payment of the rent once the plot is leased;
- guarantees return of the parcel (after the lease term) in at least the same condition as before.

The BTG works mainly through "cession" of rights between the landowner, the intermediate manager (BTG), and the final "user" of the land. It operates with the exchange of rights to use the land and not its ownership as traditional land banks do. In the case of the Galician land bank two cessions are made:

- one between BTG and the landowner: an agency contract;
- one between BTG and the final user: a leasing contract.

The Galician Land Bank has a permanent and updated list of all available plots publicly accessible and on line available. The list included basic information of the plots (location, surface, land cover, infrastructure, price etc.) and maps are available as well. Thus the Galician Land Bank stimulates land mobility by organising a flow of information through a system called SITEGAL (https://sitegal.xunta.gal).

3. Land banking as a policy process and instrument

Land, as the main natural resource any country enjoys, is subject to many political and economic interests. The question if land is a private/individual or a common good, if its use is free, restricted or on command, and if its transfer can be voluntary or forced, is mainly a policy question.

Since ancient times rulers and the elite of nations/countries used the allocation of land as one of their main instruments to wield power and control. In theocratic and autocratic systems, the control of land was centralized, but sometimes its allocation “decentralized” to feudal lords or other local “representatives” of higher central powers. Still today, such political systems exist, including in some communist and ex-communist countries with centrally planned economies, where the state controls the allocation and/or use of land, sometimes delegated down to municipalities for improved allocation. However, currently in most countries with liberal and democratic constitutions, in principal the control over and the use of land is assigned to individuals (private property, freedom to grow) and they enjoy the full rights (property right) to use and dispose (sell, lease) of it. However, the state continues to play an important role in deciding how and who can use the land, and how it can be transferred between individuals and institutions. While the constitution, through the legal and institutional framework, defines who controls the land, the policy framework defines how the land can be used. Environmental protection policy, natural resource use policy, agriculture and rural development policy, regional policy, industrial development policy, housing policy, urban (planning) policy, etc.; all have elements that infringe on the free enjoyment, disposal and use of the land.

Land banking, in terms of *policy processes* can become an important instrument for the implementation of specific land use and management related policies, to create the preconditions for specific development policies, and to implement in a non-conflictive way policies that restrict the free disposal and use of land.

As an example from the Netherlands, where such approaches are quite common, the “land users bank” of Ark and Eemland was established in 2011, with an active intermediate role to combine landscape preservation with on-farm diversification. The main idea was that farmers need extra space to expand their production while many public and private organizations owned land in the area which was leased out without a particular strategy. The Association of Ark and Eemland is a non-governmental organization that promoted agri-environment and on-farm diversification. It was the driving force behind an agreement between various institutions (municipalities, churches and the Dutch Land Bank BBL) to form a local land fund for agri-environment. Participating farmers had to accept a set of agri-environmental measures, but farmers already implementing agri-environmental measures received preferential treatment. The association mediated and managed the process while an external advisory committee did the selection on behalf of the participating organizations. In 2012, the first year of its operation about 100 hectares was leased out. This continued until 2016 when

BBL started to alienate its land as part of its closing down. Measures developed (including financial compensation measures) have been mainstreamed in provincial policies based on the regional land bank's work.

4. Land banking as a legal process and instrument

As seen in the previous section, the institutional allocation and use of land is defined by land tenure systems, traditional, customary (informal) and formal ones. While the traditional and informal ones are governed by social and ethical norms, whose rules are transferred mostly orally, the formal ones are defined by the country's institutional and legal framework. Normally the most basic definition of who can own and use land (e.g. individuals or only the state, only citizens or also foreigners, etc.) is defined by the national constitution. Civil codes or specific land codes/laws define the rights and duties of land holders/users and provide the legal underpinning of the property and use rights as defined in the constitution. However, land use and ownership can also be regulated by environmental and national resources protection laws, which limit the use of land for a higher national interest based on an intrinsic valuation of non-use or a specific use of the land; etc. Different other laws define how land as a national resource is managed (e.g. laws on state land management, privatization of land, laws on municipal ownership of land, etc.). Other laws define in details how property and use rights are recorded (e.g. laws on registration and cadaster) and how they can be exchanged or transferred (e.g. laws on land leasing, land consolidation, etc.). Finally, dispute resolution legislation and mechanism round up this short and probably incomplete characterization of the formal legal underpinning of land tenure systems.

Land banking, i.e. the activity of buying, selling or leasing of land for specific purposes as defined by policy objectives, needs a well-defined legal framework and appropriate legal instruments. A land bank, as a legal entity, demands laws that allows it to acquire, own and transfer property and use rights.

From the process point of view, a land bank can facilitate the transfer of property and use rights while guaranteeing the constitutional (and other legal) rights of the individuals or institutions involved, respecting universally accepted principles, like the "Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security - VGGT" (FAO, 2012).

From the instrument point of view, a land bank can facilitate and support the implementation of a variety of laws, while using the legal instruments at its disposal. For example, environmental and national resources protection sometimes needs the change of land use and management. While the underlying legal framework allows the state to intervene (prohibit or command) as needed, the involvement of a land bank can facilitate the change in land management and ease or prevent conflicts. The implementation of zonal/spatial plans, construction of large infrastructure (e.g. highways, high-speed train lines, etc.) and land consolidation are other examples of where a land bank can be instrumental in their implementation and prevent tensions.

For example, in the German State (Land) of North Rhine Westphalia the construction of big infrastructure is supported by land consolidation and a land banking approach. Instead of using the available legal instruments, like expropriation for public purposes, in the case of North Rhine Westphalia the implementing project institution creates a land bank for the project area, where previous to the start of the works, land is purchased and set aside for consolidating the affected farms. Thus land is exchanged in order to construct the infrastructure, while at the same time, the land use structure in the broader environment is improved and tuned to the disrupting infrastructure.

5. Land banking as an administrative process and instrument

Similar to the institutional and the legal framework, land is administered through informal and formal means. While in the informal land tenure systems traditional and customary institutions administer the land allocation and use (e.g. village chiefs, assembly of elders, etc.), in the formal land tenure systems well-defined institutions control its use, sanction misuse (mismanagement, over exploitation, use for other purposes than sanctioned, etc.) and enforce the underlying legal framework. State, regional and local institutions take over this task, e.g. cadaster and land register offices register and monitor the allocation of land (property) and its use. Other institutions implementing agriculture and rural development policies (e.g. ministry of agriculture, extension services, etc.) control the proper use of agriculture land, incentivize appropriate use or sanction misuse (through subsidies or support measures). Institutions involved in implementing environmental and national resource policies administer the proper use of the lands under their responsibility, etc.

Summarized, ownership of land and its appropriate use is guaranteed by administrations at different levels that control, enforce and sanction its use.

From the process point of view, a land bank can act as a proxy administration as it represents an intermediary between owners and users, or buyers and sellers, etc. At the same time as a proxy administrative body, it also provides the necessary guarantees for property and use rights.

Finally, from the instrument point of view, a land bank can provide crucial administrative support for implementing land consolidation schemes or the implementation of land use policies.

As an example, for the administrative role a land bank can play, the German "Landgesellschaft" could be mentioned. In Germany, most states (Laender) have rural associations ("Landgesellschaft") related to land banking, but with broader goals than only land banking. These are non-profit rural associations in the form of joint-stock corporations (limited liability company). The public utility is established in the statutes of the associations. The state is the main shareholder of the rural associations. The following organisations can be shareholders: the Federal Republic of Germany, the Federal Land Utilisation and Administration Association (BVVG), the German Settlement and Land Mortgage Bank (CDSL Bank), the Landwirtschaftliche Rentenbank, regional banks (Landesbanken) and other public corporations like corporate counties, rural districts, municipalities and regional farmers associations. For activities in the public interest the associations receive capital resources. They are subject to the specialist supervision of the respective department in the Ministry of Agriculture. Other Land related ministries are represented in the supervisory bodies. Rural associations are responsible for the development of rural areas. Among the tasks or range of services offered by rural associations, are land procurement, land utilization, forming land reserves (land banking) for measures to improve agricultural structure as well as for local and regional development projects (i.e. land consolidation), ecological and other public projects. To avoid speculation land rural associations are entitled to pre-emption.

6. Land banking as an economic process and instrument

In terms of market theory, land is a peculiar good; while it is not movable, you can trade its use- and property rights. However, some of the premises for the functioning of a free market with perfect competition are not given because of the nature of land, while others are not given because of its institutional and socio-economic environment (Dale et al., 2006). Let us just look at some of the main conditions for full market competition (Samuelson & Nordhaus, 1998):[3]

3. As one of the many possible references of economic scholars.

— Many buyers and sellers are available, each being too small to influence prices;
— Buyers and sellers do not incur in transaction costs when exchanging goods;
— Products are fully interchangeable and standardized, only the price matters;
— Prices of goods are defined by demand and supply;
— Perfect information, full access exists to economic and technical data needed for decision-making.

In the European context of rural areas, in theory there are many buyers and sellers, as a small-scale and fragmented agriculture structure prevails in many countries. However, as land has little marginal return and in many cases, the transaction costs in real land markets are not negligible, so few transactions take place (Sevatdal, 2006).

Land is not a homogenous good; depending on its location, it can have completely different characteristics and properties.

Also in many countries zoning, spatial planning, environmental and other restrictions regulate its use.

There is no "un-limited" supply of land and there are natural limitations on its use. However, with technology land could be "supplied" by reclaiming or converting unsuitable land for use. For example, the Netherlands has since centuries reclaimed land from the sea and many countries have in the 19th and 20th century drained their swamps, wetlands or river deltas, in other words "produced" land. Nowadays there are projects to create farms on floating platforms on watercourses or in multiple storey buildings, up to the utopia of "terraforming" on distant planets known from science fiction; the limit is literally the sky. However, for the purpose of this article land is a tradable good with a limited supply.

Land markets are non-perfect markets, besides the supply question treated above, one of the main deficiency are the lack of information available to market participants. Land markets are in general little transparent and decision-making is difficult as actors lack access to information to support a rational economic decision.

From the economic point of view, land banking as an economic process and instrument can serve to overcome or substitute some of the above-mentioned deficiencies, for example:

— addressing the information issue (transparency of offer and demand);

— limit the extend of transaction costs (one-stop-shop, etc.);
— provide the basis for a standard set of land quality parameters;
— address the supply issue (to a limited extend) by “uncovering” or literally “unearthing” so far un- or underused land; and
— provide all the necessary data for decision making; etc.

Hence, a land bank can convert a limited (non-existing) land market into a market, which is more open, more transparent, and more mobile.

Different from land banking approaches using a large stock of state land (e.g. BVVG,[4] Germany), or exercising an intermediate role (e.g. Galician land bank, see above) is the model of actively buying, exchanging and selling land, hence directly interfering in the land market. The land bank has more or less a constant size, since it mediates between owners and institutions. Such approaches are practiced for example in Denmark, France and the Netherlands.

An example of this approach is the French “SAFER,” which has been established in the 1960-s as a non-profit-making private company (shareholding) under government supervision. Nowadays the group counts around 27 Land Management and Rural Establishment Agencies (Sociétés d’Aménagement Foncier et d’Etablissement Rural: SAFER) in France and the overseas departments.

In the French approach the regionally based SAFER organisations (Land Development and Rural Settlement Agencies) are able to buy and sell private farm land. SAFER both stimulates the rural land market and guides it. The maximum term to keep land in stock is five years. In 2019, the land mobilized through the SAFER represented around 15% of the total rural land market. The influence of its operation is substantial, with the objective of sustainable rural development. The land management part of local, national, and European policies is supported through its 3 public service missions: development of agricultural and forest areas; local development, in close relation with projects of local authorities; and environment and landscape protection. The SAFER organisations can exercise pre-emption rights to avoid non-farmers to buy land and to avoid the speculative increase of prices. Since 1999 pre-emption rights are also practiced for protection of biodiversity and landscape.

Farmers and other promoters have to pay at each transaction for the SAFER’s public missions on the rural land market. This is charged through the sale prices. The sale price is based on the purchase price and includes notary fees and

4. BVVG: Bodenverwertungs- und -Verwaltungs GmbH - Federal Land Utilisation and Administration Association

SAFER's intervention costs. In total, added costs represent between 6 and 10 % of the purchase price (transaction costs).

SAFER's website provides access to an electronic catalogue of land parcels for sale or lease, and also provides notifications of recent developments and on-line access to relevant publications (*http://www.safer.fr/*).

7. Conclusions

Depending on the purpose and objective of a land bank, one or more of the above-mentioned dimensions become priority and define their features. As said in the introduction, different countries use land banks for different practical purposes, mostly to facilitate land transactions for improvement of farm structures (e.g. land consolidation schemes), for implementing public interest projects (e.g. infrastructure), or for implementing land use and environmental policies (e.g. nature protection areas).

Land banking as defined in the European context can have three main theoretical objectives or approaches. It can stimulate the land market (sales and rental) to adapt to changing conditions and requirements. Secondly, land banking can guide the land market towards realizing public objectives. Thirdly, it can complement land markets in these situations where the change of property rights needed to reach objectives, appears not to be possible.

Land banking from an *institutional point of view* can bridge the difference of valuation between holding and using land by transforming some of these intrinsic values into measurable values. It can guarantee that the land will be returned to the owner in the same or better state as before, and that social and cultural heritage are respected and informal rules followed by the user of the land.

Land banking, in terms of *policy processes* can become an important instrument for the implementation of specific land related policies, to create the preconditions for specific development policies, and to implement in a non-conflictive way policies that restrict the free disposal and use of land.

From the *legal process* point of view, a land bank can facilitate the transfer of property and use rights while guaranteeing the constitutional (and other legal) rights of the individuals or institutions involved, respecting universally accepted principles, like the "Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security - VGGT" (FAO, 2012).

From the *legal instrument* point of view, a land bank can facilitate and support the implementation of a variety of laws, while using the legal instruments at its disposal. For example, environmental and national resources protection sometimes needs the change of land use and management. While the underlying legal framework allows the state to intervene (prohibit or command) as needed, the involvement of a land bank can facilitate the change in land management and ease or prevent conflicts. The implementation of zonal/spatial plans, construction of large infrastructure (e.g. highways, high-speed train lines, etc.) and land consolidation are other examples of where a land bank can be instrumental in their implementation and prevent tensions.

From the *administrative process* point of view, a land bank can act as a proxy administration as it represents an intermediary between owners and users, or buyers and sellers, etc. At the same time as a proxy administrative body, it also provides the necessary guarantees for property and use rights.

From the *administrative instrument* point of view, a land bank can provide crucial administrative support for implementing land consolidation schemes or the implementation of land use policies/laws.

Finally, from the *economic* point of view, land banking as an economic process and instrument can serve to overcome or substitute some of the inherent deficiencies of land markets and can convert a limited (non-existing) land market into a market, which is more open, more transparent and more mobile.

As a conclusion, we will highlight how the above described dimensions impact on the practical purpose and theoretical objectives of a land bank on two examples.

For example if the *objective of a land bank is to provide (mobilize) land for new or existing actors (i.e. stimulate the land market)*, it has to address two of the above-mentioned dimensions, the *institutional* and the *market* dimensions.

Regarding the first – *institution* – the land bank has to bridge the gap between the intrinsic valuations of the land (as institution) and its present use value in economic terms, which in general is much lower, hence the lack of willingness of the owners to sell or even to lease it out. In order to overcome this reluctance, the land bank has to offer instruments that close this perceived gap of valuation, for example by guaranteeing the ownership rights while transferring the use rights.

Regarding the second dimension – *market* – the land bank has to overcome the limitations that land, as a tradable good is subject to in a non-perfect market situation, which is the general case in most countries. A land bank can address this in several ways; by creating transparency, limit transaction costs, provide standardized quality parameters, bringing un- or underused land into the market, and provide a database of all available land and its characteristics.

On the other hand, if the main *purpose of a land bank is to facilitate transactions for land consolidation schemes*, including public interest projects for infrastructure and implementing land use and environmental policies, the dimensions of land as a *policy* -, *legal*- and *administrative* subject become more relevant, while the institutional and market dimension are less important.

The *policy* dimension provides the overall framework in which the land bank has to act, the *legal* framework (i.e. the transcription of the policy into a legal act/law) provides the power to the land bank to act, and based on the legal framework, the land bank *administers* or implements the land transactions required by the law/policy. Hence, a land bank can be crucial to implement restrictive land use policies in a non-conflicting way, by facilitating the by law demanded change in land management/use, thus ease or prevent conflicts and prevent tensions, and finally by implementing the laws and acting as a proxy-administrator, guaranteeing the property and use rights.

As said in the introduction, land banks have been established in many countries for multiple purposes, the forthcoming publication "Land Banks and Land Funds in Europe - Instruments for Rural Development" will provide a more comprehensive overview and give many examples of existing land banks. Common to all of them is that they have specific purposes, but sometimes also confusing or conflicting objectives. This article intended to provide some background on how to improve and streamline the creation and implementation of land banks.

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Novel Debate on Territorial Planning and Land Management Policies in the Brazilian Amazon: The Case of the Alto Juruá Resex

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Abstract
Environmental crises reignite disputes about land occupancy in the Amazon and about global sustainability challenges. Owing to social demands for land access in Brazil, territorial management policies, such as Sustainable Use Conservation Units, have been created to ensure the sustainable use of natural resources. Specifically, in this study, we question whether the presence of native families in the Alto Juruá Extractive Reserve (the Alto Juruá Resex) in Acre state, Brazil, is in accordance with sustainable resource use, expressed in terms of low deforestation rates. We used the spectral and spatial attributes of the landscape to classify two Landsat satellite images (from 1990 and 2017) to describe land use and cover dynamics in the Resex. Over the 27-year period, the area occupied by pastures and crops increased tenfold. Forest use still occupies 98.63% of the total area of the Resex. The fact that most of the forest area in the region still remains is the result of a successful conservation strategy in the Amazon Forest Biome. The increased use of cattle ranching systems has not had a significant impact on the Resex area (affecting less than 1% of the area). The tenfold increase in pasture and cropland over the last three

decades indicates the complex combination of activities undertaken by the Resex residents. This is one of the reasons why policymakers and national and transnational civil society groups (such as non-profit and for-profit organizations) should abandon the creation of closed and non-dynamic sustainability models and strategies. Land and territory management policies should be requalified to guarantee that the livelihoods of these stakeholders (the Resex residents) are aligned with the premises of sustainable development principles.

Keywords: Sustainability, remote sensing, deforestation, extractive reserve, Brazilian Amazon.

1. Introduction

Land occupancy and economic exploitation of the Brazilian Amazon go back to the beginning of Portuguese colonization in the mid 16th century. However, until the end of the 1960s, the forest remained almost intact, either due to the innate difficulty of access, posed by the environment, or because the productive activities developed prior to that point were mainly extractive activities (Souza, 2010).

After 1964, the national development and integration project was intensified, and the northern region of the country was prioritized in this process. Occupancy of the Amazon increased due to the construction of roads and industrial parks, as well as to the creation of rural colonization projects and agricultural and livestock production. The expansion of a farming frontier is a manifestation of how the increase in global commodity markets is replacing local demand as the primary driver in tropical forest conversion for agriculture (De Fries et al., 2010). Road construction has also been identified as the primary driver of deforestation fires. Kirby et al. (2006) indicate that, without road access, colonization and deforestation would be virtually non-existent.

In the context of capitalist modernization, the region has gone through intense political, social, economic and environmental transformation. As a result, there has been a significant expansion of the population in the northern region of the country, as well as a reconfiguration of frontier and consolidated areas of occupation in the Amazon, including new forms of land use (Becker, 2001; Angelo & Sá, 2007; Souza, 2010). The arc of deforestation is an agricultural front where the characteristic industrial farming and cash crops have caused a marked retreat in the rainforest boundary, with the highest deforestation rates in the Amazon. The area considered is composed of 500 thousand km^2 of land that stretch from the east and the south of Pará in a westerly direction, passing through Mato Grosso, Rondônia and Acre (Malhado et al., 2010, IPAM, 2016). The expansion of this frontier is marked by the development of pastures and cropland and by clearing fires (Le Page et al., 2010). Throughout Amazonia, goods are produced in illegally deforested areas. As a result, since the 1980s, agrarian reform as well as new forms of territorial organization, including conventional and environmentally-differentiated rural settlements, and especially, protected areas for sustainable use, have been applied to the Amazonian context.

Protected areas or Conservation Units are territories with unique natural characteristics that are designated with the aim of protecting the integrity of ecosystems, biodiversity and associated environmental services. Moreover, protected areas where sustainable use is permitted ensure the territorial rights of residents and thus guarantee the livelihoods of traditional populations that have inhabited these territories for generations (Arruda, 1999; Diegues, 2004; ICMBio, 2017; MMA, 2017).

These protected areas are regulated by the Brazilian Law 9.985 of 18 July, 2000, which created the National System of Conservation Units (SNUC, in Portuguese) and established the criteria and standards for the creation, implementation and management of conservation units in Brazil. Currently, there are 2,195 protected areas in Brazil, administered by the federal, state and municipal government. The areas are organized into twelve management categories, which are divided into two major groups: Strict Protection and Sustainable Use. In Strict Protection areas, the direct use of natural resources is not allowed. These areas are only accessible for research and restricted visits. By contrast, the Sustainable Use protected areas aim to reconcile nature conservation with the sustainable use of their natural resources by the populations that traditionally reside there and exploit these resources (MMA, 2018; ICMBio, 2017). Perhaps the best known type of Sustainable Use protected area in Brazil is the Extractive Reserve (Resex), in the Amazon, the Cerrado (Brazilian savanna) and in coastal and marine areas. According to the SNUC classification, the Resex areas are used by traditional populations for whom extractive industries provide their primary means of subsistence, complemented by agriculture and small-scale subsistence ranching. The designation of Resex land aims to protect the essential natural resources which are critical for the survival of these populations, while at the same time preserving their cultural traditions and ways of life, and thus ensuring the sustainable use of natural resources (Brazil, 2000).

The concept of the Extractive Reserve as a form of territorial organization in the Amazon arose as the result of pressure from several social movements, especially from the National Council of Rubber Tappers (CNS, in Portuguese), whose main leader, Chico Mendes, was murdered in 1988. This event triggered international repercussions and brought attention to the demands of forest peoples who were opposed to the advance of large agricultural projects that threatened their way of life (Fearnside, 1989; Allegretti 1990; Diegues, 2004; Cunha & Loureiro, 2009). As a social experiment, the Resex land category posed the possibility of maintaining local populations and cultures without intensifying deforestation (Ruiz et al., 2005), a type of ecosystem degradation that is invariably observed in conventional models of territory use, i.e. large agricultural and livestock production projects and rural agrarian reform settlements. Although the Conservation Unit policy is designed for the populations that traditionally coexist in these territories, there remains some dissonance among social and productive organizations regarding institutional arrangements in the Amazon.

In this context, this article analyses the changing vegetation cover in the Alto Juruá Resex of Acre State, Brazil, and seeks to demonstrate whether the traditional lifestyle of inhabitants of this area is compatible with the sustainable use of natural resources. We use deforestation rate as a proxy for sustainability. We selected the Alto Juruá Resex for this analysis because it was the first extractive reserve created in Brazil and is emblematic in the debate on the environmental and social justice of this model of land occupancy in the Amazon region.

2. The Alto Juruá Extractive Reserve (Resex)

The Alto Juruá Resex is in the extreme western part of the state of Acre. It was the first extractive reserve in Brazil, created by Decree 98.863 of 23 January, 1990. It occupies an area of 537,946 ha, extending across four municipalities: Marechal Thaumaturgo (administrative office of the Resex), Jordão, Porto Walter and Tarauacá. The Resex is bordered to the west by lands of the Kampa tribe of the Amonia River; to the north by the Jaminawa-Arara tribe; to the south by Peru and areas of the Kampa tribe of the Breu and Kaximinaua Rivers; and to the east by the Kaximinaua tribe (Brazil, 1990; Icmbioand UFV, 2016).

The Alto Juruá Resex is in the Amazon Forest biome, with both upland (Terra Firme) and seasonally flooded forests (MMA, 2018). Following the classification of Brazilian vegetation of IBGE (2012), the upland areas of the Resex are predominantly "open" rainforests, while alluvial rainforests are found on the seasonally inundated floodplains of rivers and streams. In the Resex, the vast majority of the open forest area is dominated by semi-scandent bamboos (Guaduaspp), followed by open forest with large palms (IBGE, 2012). The dry season lasts for at least two months per year. In this region, the rainforests in the floodplains are of two types: Várzea and Igapó, which have either muddy or clear/black waters, respectively, but with similar floristic compositions. Finally, "Campinarana" is a rare type of low vegetation on leached white sands (Spodosols and Quartzarenic Neosols), with edaphically endemic plants adapted to this usually waterlogged environment (IBGE, 2012).

The territory of this protected area is mainly drained by the Juruá River, which crosses the western portion of the Resex from north to south, and by the Tejo River, which flows out of the south and then turns west, into the Juruá. The annual rainfall is 3,000 mm, and the average temperature is 30 ºC. The relief type is predominantly hilly, with slopes ranging from 3% to 20%, with a high to very high drainage density. Plains and hills mark the physiography of the area, with an elevation ranging from 250 to 300 m. The soils in the flatter terrains are Red Yellow Podzols, while Cambisols and Brunizens dominate the undulating hilly regions. The soils in the floodplains of the Juruá River, the Tejo River and their tributaries are Gleysols and alluvial soils. Two distinct geomorphological units are recognised. The first is dissected relief dominated by the erosion of the Solimões Formation - Acre River Depression - Branco River. The second is comprised of depositional sediments on alluvial floodplains and terraces of a younger "sedimentary basin" of the Juruá river (MMA, 2018).

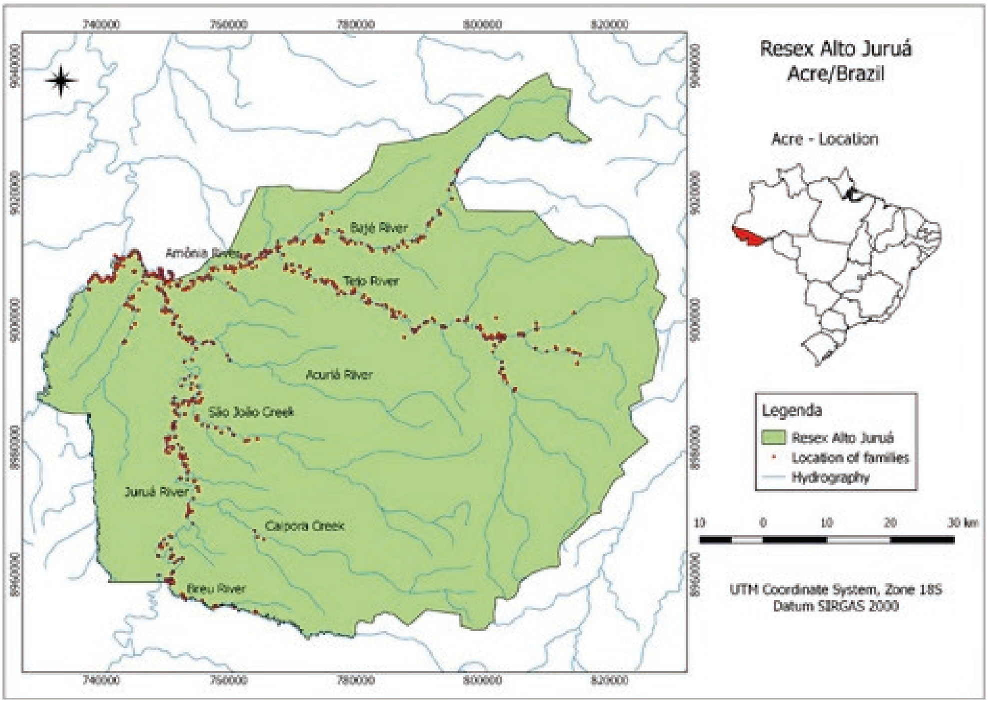

Figure 1: Family locations in the Alto Juruá Resex, AC, Brazil.

According to a census by ICMBio/UFV, in 2014 there were 1,176 families (5,715 people) living in the Alto Juruá Resex, divided among some small urban areas and dozens of rural communities along the region's extensive network of rivers (Figure 1). Most of the population lives on the banks of the Juruá and Tejo rivers and their tributaries, such as the Bajé, Acuriá, Amônia and Arara rivers, and the São João and Caipora creeks (ICMBioand UFV, 2016).

The economy of the families living in the Resex is based on non-timber forest products, mainly açaí (*Euterpe precatoria*) and natural rubber (*Hevea brasiliensis*), as well as fishing, growing cassava (*Manihot esculenta* Crantz), beans (*Phaseolus vulgaris*), tobacco (*Nicotiana tabacum* L.) and corn (*Zea mays* L.), and also cattle ranching (ICMBioand UFV, 2016). Almeida (1993) argues that the pattern of occupancy of the Alto Juruá Resex has been defined by rubber tapping, a practice dispersed throughout the forest due to the low density of native trees, being replaced by agricultural clearings and small areas for grazing cattle concentrated along the banks of the Juruá River. He also shows that more than 20 years after of the creation of Alto Juruá Resex, the deforestation levels caused by the hundreds of families that live there are still minimal.

3. Material and Methods

To examine whether the presence of families in the Alto Juruá Resex and their use of natural resources is environmentally sustainable (i.e. with low rates of clear-cut deforestation), we quantified the land use and land cover dynamics in this protected area by using Landsat satellite images. Using the Earth Explorer interface of the United States Geological Survey (USGS), we selected images from two different years: 1990 and 2017. The first image was acquired on 19/06/1990 by the Thematic Mapper sensor of the Landsat 5 orbital platform. The second is from 15/07/2017 and was acquired by the Operational Land Imager of Landsat 8. The images were in units of surface reflectance with the necessary geometric, radiometric and atmospheric corrections. We used Landsat mission images because, in addition to being free, the missions have used the same orbits, footprints, spectral bands, spatial resolution, view angle and time of day since 1984, thus enabling multi-temporal analysis of the study area on a regional scale (30 m). The same six bands sample the portion of the spectrum extending from the visible to the shortwave infrared region, providing suitable and temporally-consistent data for land cover mapping.

As each image covers a larger area than the Resex perimeter, the first step was to extract the study area. A buffer of 2 km was applied to expand the Resex polygon providing a shapefile for clipping out the study area. The images and the shapefiles used the Universal Transverse Mercator (UTM) Projected Coordinate System, Zone 18 South, and the SIRGAS 2000 Datum. This transformation requires no image resampling from the original UTM coordinate system of the downloaded USGS products.

We performed a supervised pixel-by-pixel maximum likelihood classification of the surface-reflectance images. This involves extracting training samples of each thematic land cover type of interest and then classifying each remaining pixel in the Resex into its corresponding thematic class, i.e. the class of the training data with the most-similar spectral pattern (Bins et al., 1993; IBGE, 2001; Schowengerde, 2007; Meneses & Almeida, 2012; Moreira, 2013). Classification based on spectral attributes enables elaboration of a thematic map that illustrates the geographical distribution of different categories of land cover across a given region. It should be emphasized that the supervised classification requires prior knowledge about the territory, which makes it possible to establish correlations between the specific training areas on the image and the land cover classes of interest.

Taking into account historical aspects related to the land occupancy (Almeida, 1993; Rezende, 2010; Acre, 2010; ICMBio and UFV, 2016), as well as the geomorphological and edaphic characteristics of the region (Acre, 2010; IBGE, 2012; MMA, 2018), and with the aid of high-resolution images available from Google Earth®, we identified, via visual interpretation, three macro classes: Water, Forest and Pasture/Crop. We combined the IBGE-mapped Open Upland Forest and Alluvial Floodplain Forest into a single category, called Forest, since the aim of the study was to measure overall forest conversion attributable to human activities.

To include both upland and floodplain forests in the Forest class, we also consulted the SRTM Digital Elevation Model, with a spatial resolution of 30 m, available on the Earth Explorer site (USGS, 2018). For each of the three macro classes, we collected 20 well-distributed and similar training samples (3 x 3 pixels) throughout the image, of which 70% were used for classification and 30% were reserved for validation in an error matrix.

The maximum likelihood classifier considers the shortest distance in band space between each pixel to be classified and the three training sample centroids, based on statistical parameters. Distances are non-Euclidean, as they are adjusted by the degree and the direction of dispersion of each of the three training pixel clouds surrounding each centroid. The method assumes that each training pixel cloud has a normal distribution along any given band axis (IBGE, 2001; Meneses and Sano, 2012).

Validation of the classification consists of evaluating its accuracy. A result with 100% accuracy indicates that all pixels of the validation set ("ground truth," reference) data set were classified correctly. Therefore, the closer to 100%, the better the classification quality (IBGE, 2001; Meneses and Sano, 2012). Accuracy is usually evaluated using indices calculated from the "error matrix" or "confusion matrix" that compares the relationship between the reference data and the corresponding classification results, class by class (Meneses and Sano, 2012). We used the Kappa accuracy index to evaluate the overall accuracy of the 1990 and 2017 classification results. This index varies from 0 (zero agreement) to 1 (perfect agreement) (Abraira, 2001; Meneses and Sano, 2012).

In addition to the six optical bands that the two image dates have in common, the classification band space included a synthetic group, using the Normalized Difference Water Index (NDWI) to facilitate the differentiation and delimitation of watercourses. The value of the NDWI varies from -1 to 1, where an NDWI ≥ 0 indicates that the cover is water and an NDWI ≤ 0 indicates a type of cover other than water (McFeeters, 1996; Brenner & Guasselli, 2015; Barbosa et al., 2018).

NDWI = (G-NIR) / (G+NIR) (1)

where:

NIR = Near-Infrared Band, corresponding to the reflectance at the wavelength between 0.76 and 0.90 μm.

G = Green Band, corresponding to the reflectance at the wavelength between 0.52 and 0.60 μm.

To supplement the analysis, we conducted in situ observations in the Alto Juruá Resex. Ten days of fieldwork allowed for daily contact with resident families and landscape recognition. We also obtained access to the results of the socio-economic and productive diagnosis of the Resex, carried out in 2014, which includes detailed data on the social, economic and productive reality of the families to support the analysis.

4. Results and Discussions

The results of the image classification process indicate satisfactory Kappa indices of 0.93 and 0.95 for 1990 and 2017 respectively, which validates the classification. According to Landis and Koch (1977), Kappa indices between 0.81 and 1.0

indicate "almost perfect" rankings. Figure 4 and Table 1 show the overall dynamics of land use and cover within the study site.

We also verified that in 1990, the year when the Resex was created, 98.63% of the area was composed of our broad "Forest" class, including Upland Open Rain Forest and Alluvial Floodplain Open Rain Forest (Table 1). The watercourses (open water not occupied by floodplain forest) made up 0.56% of the Resex area. It is worth noting that in this study, fields of white sand vegetation (Campinarana) were classified as Forest, due to scale. We also verified the presence of pastures, mainly in the floodplain, which represented 0.10% of the Resex area in 1990. The predominance of grasslands in the floodplains is in accordance with the historical regional trend of the occupancy of the riverbanks by traditional populations.

The results obtained correlate with the occupancy history of this studied Conservation Unit, which, according to Almeida (1993), indicates a pattern of occupancy characterized by the increased clearing of pastures and agricultural areas by rubber tappers.

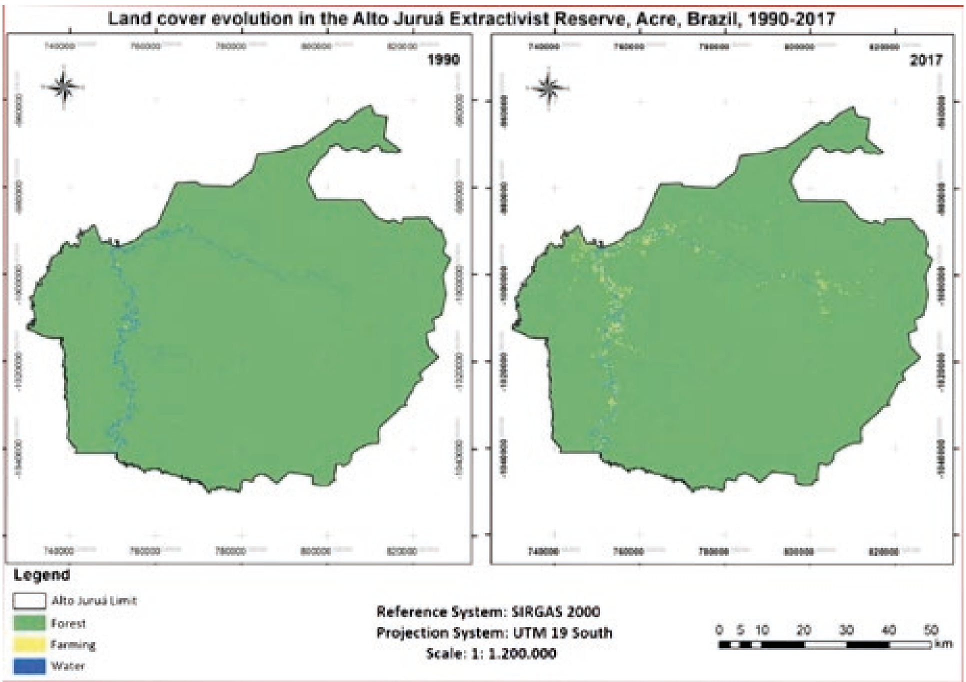

Figure 2: Land cover in the Alto Juruá Resex, Acre state, Brazil, in 1990 and 2017.

Class	1990(ha)	% of the total area	2017(ha)	% of the total area
Water	2,811.38	0.53	2,293.53	0.42
Forest	535,204.60	99.37	531,173.60	98.63
Pasture/Crop	557.84	0.10	5,106.32	0.95

Table 1: Overall land-cover dynamics in the Alto Juruá Resex/Acre, 1990-2017.

From 1990 to 2017, the Forest area was reduced by only 0.8%, despite a tenfold increase in the area of the pasture/crop class. We also identified a decrease of 18.42% in the area covered by open water. This reduction may be due to the period of acquisition of the 2017 image. Due to the rainfall regime, the river water level can vary significantly in the Amazon from one month (and year) to another, thus affecting the total open water area.

The literature review and the model of Sustainable Use Protected Areas (Almeida, 1993; 1992; 2012) indicate that the organization of the territory in the Alto Juruá Resex is defined by the traditional forms of land use: extractive industries, subsistence agriculture and livestock farming, as well as by its inhabitants, i.e. the families living mainly along the riverbanks. The form of social, economic and environmental organization in this extractive reserve is consistent with the low deforestation rates, as the forest cover decreased by only 3.8% in 27 years, which is much lower than the annual rate of deforestation in the Amazon (roughly 14% in 2017-2018). This finding is extremely relevant, especially considering that hundreds of families make a living from of the rational and sustainable use of the natural resources from this area, as well as the intense deforestation observed around this Resex and in other regions of Acre state and the Brazilian Amazon. The accumulated deforestation rate between 1988 and 2017 was 428,721 Km^2 in the Brazilain "Legal Amazon," with the state of Acre contributing 3.3% of this total (INPE, 2018).

5. Final Considerations

The overall land cover dynamics in the Alto Juruá Resex suggest that the institutionalization of this extractive reserve has certainly boosted the occupancy of the area, as approximately 37% of households claimed to reside in the Resex area after its creation (ICMBio and UFV, 2016). The intensification of occupancy and use has mainly occurred through the conversion of forest to farming, mostly along the banks of the Juruá and Tejo Rivers, as we found by comparing the land cover maps from 1990 and 2017.

The tenfold increase in the area of pasture and cropland in the Resex, from its creation to the present day, is technically incompatible with the land uses foreseen by the SNUC for an extractive reserve, their focus theoretically being based on extractive activities, subsistence farming and small-scale livestock farming. However, although cattle pastures are prohibited in the Resex, it should be noted that the impact of this activity represents only 0.95% of the total area of the Resex, with an average of only 5 ha per family. This dimension indicates that cattle pasture has been developed as a complementary activity to aid in the subsistence of these families and does not yet compromise the sustainable use of natural resources in this Resex. Indeed, the existence of traditional activities with little impact on the natural vegetation cover indicates the need for revision of the SNUC, mainly to allow for and to regulate other possible sustainable types of land use, such as small-scale cattle grazing, in extractive reserves. The literature (Almeida 1993; 2012) itself shows that, historically, such activity had already been developed by rubber tappers in the region, and that, as shown in the present study, these activities have not entailed large clearcutting over the years. Thus, the example of the Alto Juruá Resex indicates that the Sustainable Use Protected Areas model is a suitable alternative for organization of the Amazonian territory, as it preserves traditional forms of social organization while at the same time maintaining low rates of deforestation.

Nevertheless, although pasture and cropland represent only 0.95% of the total area of the Resex, the associated activities, much like the local population settlements, are highly concentrated on the riverbanks, indicating a more intensive use of resources in relatively small areas compared to the overall Resex area. Consequently, land conversion has a greater impact along the watercourses, which raises concerns regarding water quality in those areas where the inhabitants and farming are concentrated. Through in situ observation, we were able to verify that the pasture areas located along the riverside are simple and rudimentary. The extensive production system of cattle ranching does not involve the use of technology and modern practices. In 2014, 23% of the Resex residents declared that they practice cattle ranching, and only 10% of them stated that they are active in dairy production (ICMBio and UFV, 2016). The cattle ranching system is used only for family consumption and to complement income, rather than as a primary source of income in the Resex.

It is also important to emphasize the role of Geographic Information Systems (GIS) in assisting the planning and management of territories. GIS can be used as an instrument for many purposes, including Land Use Planning and Environmental Management, offering diverse possibilities to aid in planning and management. The use of GIS enables working with a multiplicity of data simultaneously and easy visualization of the data, thus allowing for comprehensive and detailed analysis of different territories. In addition to GIS, Remote Sensing is also an essential geotechnology, which enables extraction of information that would be impossible to obtain with the naked eye.

The debate on the social and productive occupancy of the Amazon must be reformulated, embracing the different cultural traditions and political influences, both on local and geopolitical scales. Land policies and the management of Extractive Reserves must be re-qualified and resignified to guarantee the subsistence of local inhabitants according to the premises of sustainable development.

The scope of conservation in protected spaces is a fundamental premise to ensure efficient territorial and resource management. However, conservation must be implemented according to the demands of residents and be committed to the well-being of land users. Taking into account the historical context of land use, exploring the complexity of the different factors and elements that have caused the environmental crises in the Amazon can provide the necessary clues to understand ongoing processes and the essential strategies needed to create governance conditions that ensure the maintenance of a balance between living conditions, economic opportunities, environmental preservation and sustainable use of resources in the Brazilian Amazon.

As a limitation of the research, we point out the limited use of qualitative methodological instruments. Instruments such as in-depth interviews and focus groups are essential in order to thoroughly investigate the current needs and demands of the Resex's residents, and to explore different mechanisms to meet their needs when designing institutions and public policies.

Acknowledgements

This study was partly financed by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

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Biosphere Reserves of the Spanish Atlantic region: protected areas for the conservation of biodiversity and sustainable development.

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Abstract
November 2021 will mark the 50th anniversary of UNESCO's Man and Biosphere (MaB) program. During its 50 years of operation, this program has established a new approach to biodiversity conservation, based on a zoning of the territory and the application of the sustainable development concept. Under this program, 714 Biosphere Reserves have been designated in the World Network. At present Spain is the country with the highest number of designated Reserves in the world, with a total of 53, of which 20 are included in the Atlantic biogeographical region. The declaration of this set of Spanish Atlantic Reserves has allowed the development of different projects aimed at the conservation and restoration of protected habitats and species, as well as the implementation of actions in these Biosphere Reserves to improve the use of natural resources, the life quality of their human residents, as well as their knowledge and capacity building. The proposed Ribeira Sacra and Serras do Oribio e Courel Biosphere Reserve represents an important addition to the Biosphere Reserves of the Spanish Atlantic region. The updated analysis of this set of reserves is presented in the present document.

1. Introduction

After the declaration of the first natural protected areas, the American model of National Parks and Monuments, will be gradually transferred to other continents and countries until it reaches an important development and covers important milestones in the conservation of biodiversity and the planet's natural heritage. However, the natural areas model will generate frequent problems with the local populations, especially when making the conservation objectives compatible with the use of resources that had been carried out in the territory or that were incorporated after the protected area declaration, which determined that in the middle of the 20th century the surface of natural areas had stagnated in many countries and even worldwide (Chape et al. 2005). This situation changed during the 1970s with the incorporation of two new figures: Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, Iran, 02/02/1971), and the Biosphere Reserves created by UNESCO in 1974 under the Man and Biosphere Program (MaB).

Faced with the need to seek a fair balance between economic, social and environmental needs, the United Nations Conference on Environment and Development (Rio de Janeiro, Brazil) was held in 1992, known as the "Earth Summit". At this meeting, the Convention on Biological Diversity (CBD), signed to date by 196 Contracting Parties, was approved, and its main objectives were the conservation of biological diversity, the sustainable use of its components, and the fair and equitable distribution of benefits derived from the use of genetic resources. Months before the celebration of the Earth Summit, the Council of the European Communities promulgated Directive 92/43/EEC, which established the creation of the Natura 2000 Network, on which a new nature conservation policy was established in the European Economic Community (today the European Union).

Currently in the territory of the European Union two models of protected area networks coexist, the Biosphere Reserves and Natura 2000. Despite the both have a clearly different configuration, organization and operation, they have shared since their inception common objectives aimed at the conservation of biodiversity and sustainable development (Ramil-Rego & Ferreiro da Costa 2014). This coincidence determines that in many cases there is a strong complementarity between both figures, resulting in greater effectiveness of their objectives and especially in a greater interrelation of environmental policies with the people that lives in these territories.

The Biosphere Reserves have been consolidated as a long-term conservation model (50 years in force), being a successful example of adaptive management, for which the latest trends and the best available scientific-technical knowledge have always been incorporated. The Rio Earth Summit, the Convention on Biological Diversity, or the European Biodiversity Strategies have had a broad impact on the evolution of the Man & Biosphere Program through the implementation of the successive Action Plans of the World Network of Biosphere Reserves (Batisse 1986, 1990, 1996; UNESCO 1984, 1985, 1996, 2006, 2008, 2009, 2017). Thus, while in the late 1970s the MaB Program advocated achieving a lasting balance between biodiversity, economic development and cultural heritage, over time the conservation of protected areas has become unthinkable without simultaneously formulate the development needs of local communities. Therefore, there has been a convergence between conservation and local development, in accordance with the objectives of the Convention on Biological Diversity, consolidating the MaB program as one of the most powerful initiatives for the conservation of natural and cultural biodiversity throughout world level, as well as for the promotion of sustainable development (UN 1987). Nowadays, after the last meeting of the International Coordination Council held online in October 2020 (UNESCO 2020), the World Network of Biosphere Reserves has been raised up to a total of 714 designated Reserves in 129 countries around the world.

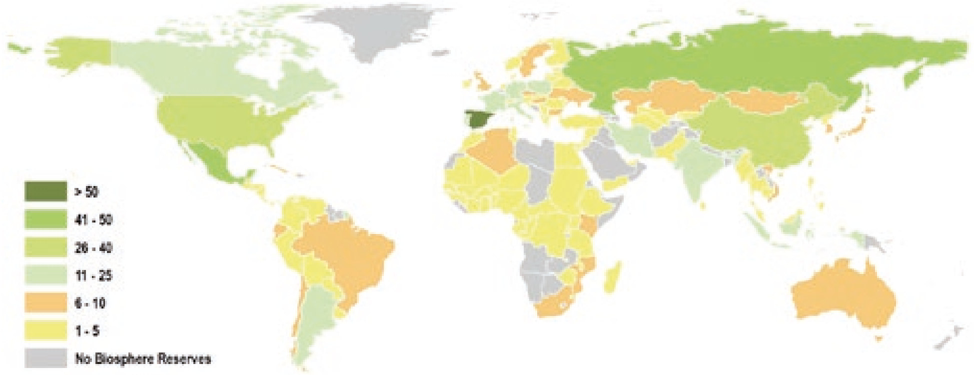


Figure 1: Distribution per country of the World Network of Biosphere Reserves. Prepared from UNESCO (2020).

Spain is one of the countries in the world that has made greater promotion of the figure of Biosphere Reserve, both from a regulatory point of view, as well as because the number of declared Reserves (Figure 1). The Spanish Atlantic portion has played a major role in the configuration of the Spanish Network of Biosphere Reserves (Ferreiro da Costa & Ramil-Rego 2018), hosting the areas of greatest biodiversity in the Iberian Peninsula. The first Atlantic Biosphere Reserves were declared more than 30 years ago (Urdaibai, Muniellos, Somiedo, Redes and Terras do Miño), and in some cases, such as Terras do Miño, the knowledge generated on the occasion of their declaration (Crecente Maseda & Ramil -Rego 2000) motivated the implementation of new conservation initiatives, which still persist to this day.

This work provides an updated evaluation of the Biosphere Reserves in the Spanish Atlantic region, assessing the values housed, their governance model, and the implementation of different projects aimed at the conservation and restoration of protected habitats and species. This diagnosis includes the proposal for Ribeira Sacra and Serras do Oribio e Courel Biosphere Reserve, which has now satisfactorily passed the reports of the Spanish MaB Committee (September 2020) and the UNESCO International Consultative Council (June 2021), and is only pending approval by the International Coordinating Council of the MaB program, which will meet in autumn 2021. Thus, this work constitutes the first joint analysis of the Spanish Atlantic Biosphere Reserves including the Ribeira Sacra e Serras do Oribio e Courel Biosphere Reserve, whose official declaration, by UNESCO, is scheduled to be made during the current year 2021.

2. Origin of MaB program

In 1968, UNESCO held in Paris the Intergovernmental Conference of Experts on the Scientific Bases for Rational Use and Conservation of the Resources of the Biosphere, where the uses and conservation of natural and environmental resources were analyzed. In the Conference, the biosphere is defined as an ecosystem where the levels of organization of life and the environment are carried out according to the modes of combination of organisms and their physical-chemical conditions. As a conclusion of the Conference, it was recommended to establish an international research program on man and the biosphere; conduct research on biosphere pollution and control measures; utilization and preservation of genetic resources; rational use of natural resources; develop an integrated policy for the exploitation of the environment; preservation of natural regions and threatened species; create research and training centers for the inventory and evaluation of resources; develop assistance projects in developing countries and involvement in the program developed by UNESCO focused on scientific, technical and educational aspects of the problems of rational use and conservation of biosphere resources (UNESCO 1969, 1971, 1972, 1981, 1984, 1996; Batisse, 1984, OAPN, 2012; Ramil-Rego et al. 2011, Ferreiro da Costa et al. 2011).

In 1971, UNESCO approved the launch of the M&B Program (Man & Biosphere), as a research program within the natural and social sciences aimed at the search for new models of conservation and rational use of natural resources of the Biosphere, simultaneously seeking to improve the global relationship between people and the environment.

In 1974, UNESCO encouraged the meeting of a working group of the M&B Program, which raised the need to reorient the program and create pilot areas for the fulfillment of its objectives, which will be designated as "Biosphere Reserves". Two years later, the first world Reserves are designated, and their number will increase in successive years, so that, in 1995, there were 324 areas distributed in 82 different countries. The success of the program and the need to strengthen it, led UNESCO to hold in Seville, March 1995, an international conference of experts from the Man & Biosphere Program, in which two essential documents were drawn up: the Seville Strategy for Biosphere Reserves and the Statutory Framework of the World Network of Biosphere Reserves. Both documents were later officially adopted under Resolution 28/C/2.4. of the UNESCO General Conference in November 1995.

Biosphere Reserves are an essential element of UNESCO's M&B Program. They are areas of terrestrial, coastal or marine ecosystems in which the conservation of natural resources and the economic and social development of local communities are promoted, taking into account all the social, cultural, and economic needs of their inhabitants, supported by a scientific base. Biosphere Reserves are exceptional areas for research, long-term observation, training, education and public awareness, while allowing local communities to fully participate in the conservation and sustainable use of resources.

According to the Statutory Framework of the World Network of Biosphere Reserves (UNESCO 1996), Biosphere Reserves must fulfill three basic functions: 1.- Conservation: contribute to the conservation of landscapes, ecosystems, species and the genetic variation. 2.- Development: promote sustainable economic and human development from the sociocultural and ecological points of view. 3.- Logistical support: provide support to demonstration projects, education and training on the environment and research and permanent observation in relation to local, regional, national and global issues of conservation and sustainable development. All the Biosphere Reserves approved by UNESCO make up the World Network of Biosphere Reserves as demonstration sites that offer effective responses to new challenges, such as the loss of traditional knowledge and biological and cultural diversity, the loss of arable land, changes in land use or climate change, in a framework that aims to promote practices in accordance with a sustainable development model.

The Statutory Framework of the World Network of Biosphere Reserves (UNESCO 1996) also establishes the general criteria that a territory must satisfy in order to be designated a Biosphere Reserve: 1.- Contain a mosaic of ecological systems representative of important biogeographical regions that integrate a progressive series of forms of human intervention. 2.- Be important for the conservation of biological diversity. 3.- Offer possibilities to test and demonstrate sustainable development methods on a regional scale. 4.- Have sufficient dimensions to fulfill the three functions of the Biosphere Reserves (conservation, development, logistical support). 5.- Fulfill the three mentioned functions through a zoning system configured by three units: core zones, buffer zones and transition zones. 6.- Apply organizational provisions that facilitate the integration and participation of an adequate range of sectors, among other public authorities, local communities and private interests, in the conception and execution of the functions of the Biosphere Reserve. 7.- Having taken, in addition, measures to equip itself with: a.- Management mechanisms for the use of resources and human activities in the buffer zones. b.- A policy or a management plan for the area as a Biosphere Reserve. c.- An authority or an institutional body in charge of applying that policy or plan. d.- Research, education and training programs.

For the fulfillment of its three fundamental functions, the Biosphere Reserves must have an adequate zoning established from a system of three units: Core, Buffer, Transition. The core zone or zones must be “legally constituted” and dedicated to long-term protection in accordance with the conservation objectives of the Biosphere Reserve, large enough to meet those objectives. The buffer zones must be clearly defined, surrounding or bordering the core zones, where only activities compatible with the conservation objectives can take place. Finally, the Biosphere Reserves must have one or more transition zones, where forms of sustainable resource exploitation are promoted and practiced (UNESCO 1996).

3. The promotion of Biosphere Reserves in Spain

Spain has undoubtedly been a worldwide reference (Bonnin & Jardin 2009) in the development of Seville Strategy’s objectives after its approval in 1995, as well as in the application of the criteria of the Statutory Framework of the World

Network of Biosphere Reserves, thus becoming one of the countries that has contributed the most to the application of the concept of Biosphere Reserve. The configuration of an appropriate strategic and action framework in the Spanish Biosphere Reserves was completed with the legal support established through Law 42/2007 and its firm commitment to the integration of the Biosphere Reserves within the legal framework in matters of natural heritage and biodiversity, making Spain a benchmark for subsequent legislative texts that would emerge in different European countries (Comba 2011).

The promotion of the designation of new Biosphere Reserves in the Spanish territory after the year 1995 currently places Spain in a privileged position within the World Network of Biosphere Reserves. The Biosphere Reserves declared in Spain constitute, according to Law 42/2007, the Spanish Network of Biosphere Reserves, which facilitates the exchange of information, experiences between them, coordinated by the National Parks Autonomous Agency (acronym in Spanish, OAPN). The Spanish Network of Biosphere Reserves is composed by a total of designated 53 Biosphere Reserves, 7% of the world's list, which makes Spain the country that has designated the largest number of Biosphere Reserves. Thus, Spain ranks above countries with a much larger territorial scope (Figure 1), such as Russia (46 Reserves), China (34 Reserves) or the United States (28 Reserves). This comparison is more relevant when comparing the set of designated Spanish Reserves with respect to other European countries such as Germany (16 Reserves), France (14 Reserves), Portugal (11 Reserves) or the United Kingdom (7 Reserves).

The set of 53 Spanish Biosphere Reserves (Figure 2) houses a wide variety of habitats, ecosystems, socio-economic and population realities. Consequently, areas in which coastal ecosystems have a predominant role (such as island reserves) are included in Spanish Network of Biosphere Reserves, as well as other ones that are linked to high mountain ecosystems, other ones that have been delimited around wetland complexes, and other ones that are made up of traditional agrosystems. With respect to socioeconomic and population variability, a wide variety of situations are also recorded, including from Biosphere Reserves where the population is high or with significant population densities, to Reserves that host almost unpopulated areas.

The key aspects of Statutory Framework of the World Network of Biosphere Reserves about zoning have been introduced into the Spanish legislative framework, through Law 42/2007, which considers that the core areas must be Natural Protected Areas or Natura 2000 Network Protected Areas, duly declared, provided with their corresponding management instruments, and surrounded by buffer and transition zones. In both network models of Biosphere Reserves and Natura 2000, the areas that must be part of them must meet a set of environmental criteria, evaluated in the context of a biogeographical sectorization, which will also have an incidence in relation to the organization and management of protected areas. The introduction of the concept of biogeographical region through Directive 92/43/EEC, on the occasion of the designation of the areas to form part of Natura 2000, provides an ideal geographical framework for the analysis of protected areas, as it has been revealed in numerous scientific works (Evans 2005, Ferreiro da Costa & Ramil-Rego 2018), and as it is reflected in this document. The methodology for the design and development of the concept of biogeographical region has evolved through the years (Roekaerts 2002, EEA 2002, 2008; ETC / BD 2006), based on the first vegetation maps of the European Union (Ozenda et al. 1979, Noirfalise 1987, Bohn et al. 2000-2003).

Figure 2: Distribution of Spanish Network of Biosphere Reserves with respect to biogeographical regions. Prepared from EEA (2016) and MITECO (2021).

From a geostatistical point of view, the Spanish Biosphere Reserves have been fundamentally delimited around the Mediterranean biogeographical region. A total of 33 Biosphere Reserves are totally or partially included within this region, with a total area of 51,475 km2. This value is significantly higher in absolute value with respect to the Reserves totally or partially delimited in the Atlantic region, which include a set of 20 Reserves, including a total area of 14,443 km2. These differences are even greater with respect to the Biosphere Reserves in the Macaronesian or Alpine regions of Spain. However, if the analysis is relativized from a biogeographical point of view, the values indicate a completely different reality (Table 1).

Region	**% Spain**	**N Reserves**	**Biosphere Reserves Area (km2)**			**% Region**
			Total	**Marine**	**Continental**	
Mediterranean	85,7 %	33	51.475	5.709	45.766	10,6 %
Atlantic	11,0 %	20	14.443	33	14.410	25,8 %
Alpine	1,9 %	1	980	---	980	10,3 %
Macaronesian	1,4 %	7	8.324	4.676	3.648	47,2 %

Table 1: Surface distribution by biogeographical region of the Spanish Biosphere Reserves. Prepared from EEA (2016) and MITECO (2021).

The 33 Spanish Mediterranean Biosphere Reserves include a total area of 51,475 km2, of which 45,766 km2 are land area. This means that 10.6% of the Spanish Mediterranean area has been included into the Spanish Network of Biosphere Reserves. In the Spanish Atlantic region, the 20 Reserves occupy a total area of 14,443 km2, of which 14,410 km2 belong to land surfaces, which represents that the Biosphere Reserves reach more than a quarter (25.8%) of the total Atlantic surface. In the Spanish Macaronesian Region the 7 declared Biosphere Reserves occupy a land area of 3,648 km2, which means 52.4% of the continental territory. Consequently, both in the Atlantic and Macaronesian regions the values of the terrestrial proportion included in the Spanish Network of Biosphere Reserves are significantly higher than the proportion reached in the Mediterranean region (Table 1). Atlantic and Macaronesian values exceed the index values of Aichi's targets (CBD 2010) regarding the need to include at least 17% of the continental territories within some type of protected area, they are consistent (or even above) with today's EU protected land area which is 26% (EEA 2020a, 2021), and even they are included (or very close) within the established interval (from 30% to 70%) established in the EU Biodiversity Strategy to 2030 (EC 2020) from scientific studies' figures range (IPBES 2019).

The high proportion of the Spanish Atlantic Region (25.8%) that has been included within the Biosphere Reserves, protected areas created to conserve biodiversity and promote sustainable development, is consistent with the territorial distribution of habitat diversity in the Iberian Peninsula (Figure 3). In the Spanish Atlantic region there is a high presence of areas with the greatest abundance of habitats in the Iberian Peninsula (Ramil-Rego et al. 2008a), and even in the European Union (EEA 2020b, EC 2021a), which is indicative of the biodiversity sheltered by the Iberian Atlantic area (Figure 4). This allows to verify that in this region sustainability has governed the management and conservation of this territory, and therefore has allowed the establishment of a large set of Biosphere Reserves in the Spanish Atlantic region.

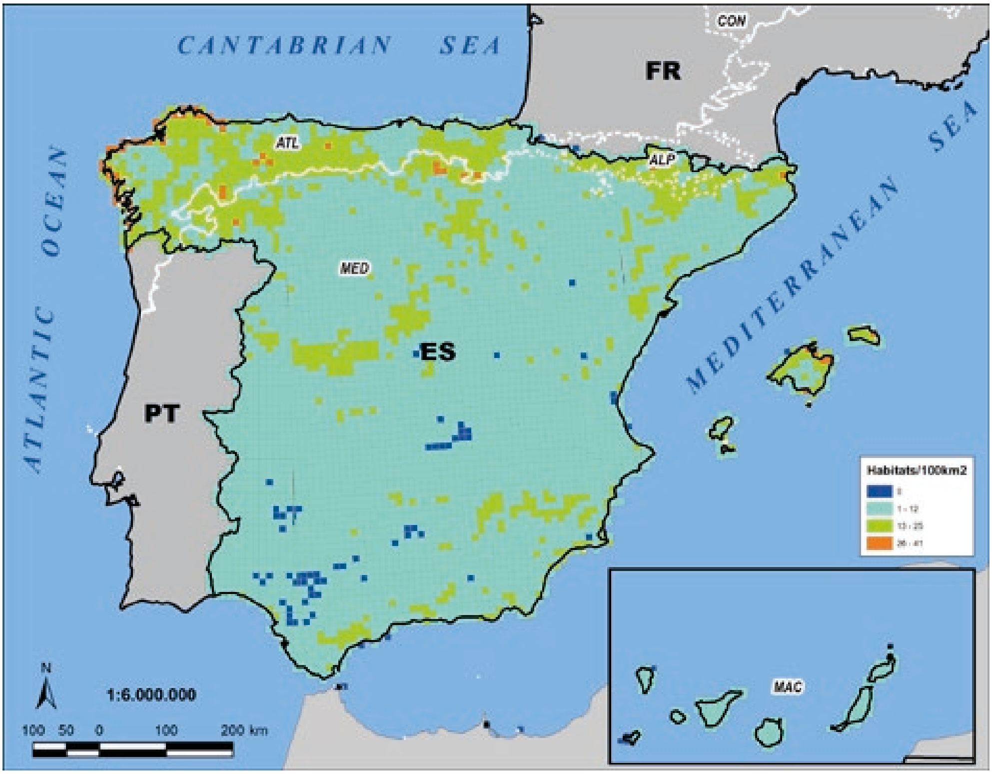


Figure 3: Number of habitats per 10 x 10 km2 UTM grid in Spain with respect to biogeographical sectorization. Prepared from Ramil Rego et al. (2008a) and EEA (2016).

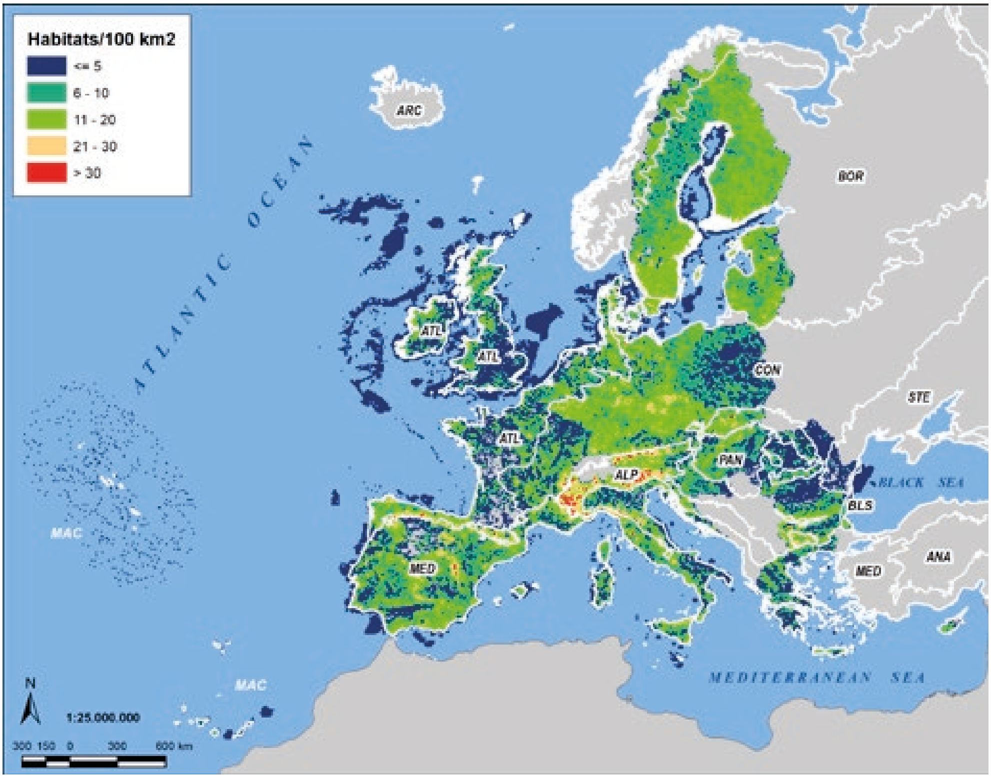


Figure 4: Number of habitats per LAEA 10 x 10 km2 grid in the European Union, with respect to biogeographical regions. Prepared from EEA (2016, 2020b).

The reason for the biodiversity harbored by the Spanish Atlantic portion combines climatic and geographical factors (Rodríguez Guitián & Ramil Rego 2007, 2008; Ninyerola et al. 2005). Rainfall occurs abundantly and well distributed throughout the year, so that summer drought does not exist or is very low, since even in summer the moisture-laden N-component winds provide effective and hidden precipitation. The extension towards the continent does not exceed 120 km from the shore of the Atlantic Ocean, which produces a low continentality and therefore a reduced annual thermal amplitude, especially compared to territories further away from the sea, in which continentality produces a greater oscillation between winter and summer temperatures. All this causes the optimal conditions for Atlantic vegetation to converge in the Spanish Atlantic portion (Loidi et al. 2010), which allows a greater variety of ecosystems (Rivas-Martínez et al. 2001, Díaz González & Fernández Prieto 1994, Loidi et al. 1997), and consequently a greater richness of habitat types (Ramil-Rego et al. 2008a,b) and species (Loidi et al. 2007, Rey & Montaña 2003, Assunçao-Albuquerque et al. 2012, Gómez & Lunt 2006).

4. Environmental values of the Spanish Atlantic Biosphere Reserves

The Biosphere Reserves delimited totally or partially in the Spanish Atlantic Region form a set of 20 Biosphere Reserves (Figure 5) whose total area amounts to 14,443 Km2, of which 33 Km2 (0.2% of the total) correspond to marine waters while the remaining 14,410 km2 (99.8% of the total) correspond to land areas within the Atlantic region. In this set of Biosphere Reserves a wide range of ecological environments are represented, being possible to identify reserves in which the marine, littoral and coastal environments are represented (Urdaibai, Mariñas-Mandeo, Río Eo-Oscos-Burón), while in other cases wetlands are the main theme (Terras do Miño). There are also examples in which traditional agrosystems are the main component (Allariz), although most include inland mountain ranges and valleys (Muniellos, Laciana, Babia, Omaña-Luna, Alto Bernesga, Los Argüellos, Gerês-Xurés, Redes, Ribeira Sacra-Oribio-Courel) or mountain ecosystems (Somiedo, Picos de Europa, Ancares Lucenses, Ancares Leoneses, Ubiñas-La Mesa).

This wide range of represented ecological environments is accompanied by a wide range of typologies of the management bodies of the Biosphere Reserves in the Spanish Atlantic Region (Table 2). Half of them are managed by the Regional Governments, since they are responsible for the conservation and management of biodiversity and natural heritage. All the Reserves managed by Regional Governments, with the exception of Ribeira Sacra and Urdaibai, coincide totally or partially with national, natural or regional parks, mainly due to the Asturian management model of Biosphere Reserves, where both figures (Biosphere Reserves and National/Natural Parks) have practically a coinciding delimitation. However, it is also possible to identify Reserves managed by provincial governments (such as Terras do Miño and Os Ancares Lucenses), local entities and consortiums (such as Valles de Omaña y Luna, Los Argüellos, Ancares Leoneses, or Babia), and NGOs (foundations or associations) intended for this purpose (such as Mariñas-Mandeo, Valle de Laciana, Alto Bernesga or Area de Allariz).

[1]: Mariñas-Mandeo; [2]: Terras do Miño; [3]: Río Eo-Oscos-Burón; [4]: Ancares Lucenses; [5]: Ancares Leoneses; [6]: Muniellos; [7]: Somiedo; [8]: Las Ubiñas-La Mesa; [9]: Valle de Laciana; [10]: Babia; [11]: Valles de Omaña y Luna; [12]: Alto Bernesga; [13]: Argüellos; [14]: Redes; [15]: Ponga; [16]: Picos de Europa; [17]: Urdaibai; [18]: Área de Allariz; [19]: Gerês-Xurés; [20]: Ribeira Sacra-Oribio-Courel.

Figure 5: Territorial distribution of Biosphere Reserves in the Spanish Atlantic Region. Prepared from EEA (2016) and MITECO (2021).

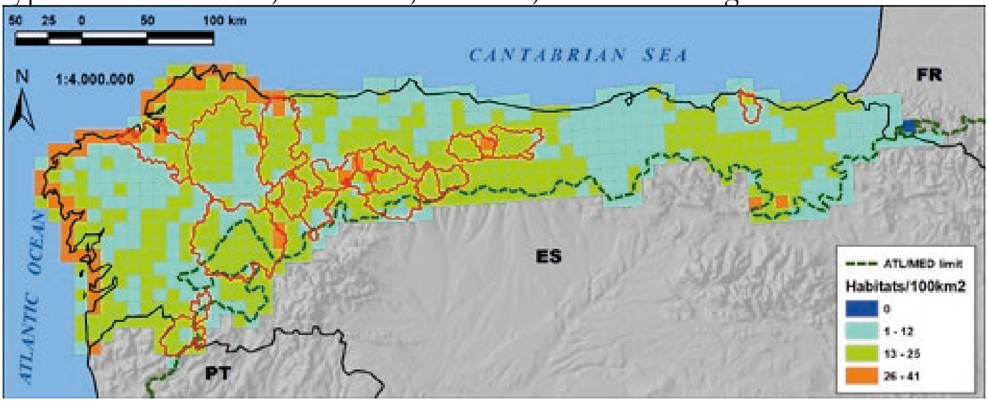
	NP	Management body	Number of hábitat types		
			Total	Priority	Non-priority
Mariñas-Mandeo	-	Foundation/association	49	12	37
Río Eo-Oscos-Burón	-	Regional Government	48	12	36
Picos de Europa		Regional Government	41	10	31
Ribeira Sacra	-	Regional Government	37	11	26
Somiedo		Regional Government	37	8	29
Valles de Omaña y Luna		Local entity/consortium	36	10	26
Terras do Miño	-	Provincial Deputation	35	11	24
Os Ancares Lucenses	-	Provincial Deputation	35	11	24
Las Ubiñas-La Mesa		Regional Government	35	8	27
Redes		Regional Government	34	8	26
Ancares Leoneses	-	Local entity/consortium	34	8	26
Muniellos		Regional Government	33	7	26
Babia		Local entity/consortium	33	9	24

	NP	Management body	Number of hábitat types		
			Total	Priority	Non-priority
Valle de Laciana	-	Foundation/association	32	8	24
Urdaibai	-	Regional Government	32	6	26
Alto Bernesga	-	Foundation/association	30	8	22
Los Argüellos	-	Local entity/consortium	29	7	22
Gerês-Xurés		Regional Government	28	8	20
Ponga		Regional Government	19	5	14
Área de Allariz	-	Foundation/association	13	2	11
TOTAL			**78**	**19**	**59**

Table 2: Richness of habitat types and management bodies in the Biosphere Reserves of the Spanish Atlantic Region. [NP]: National/natural/regional park (total or partial coincidence).

The set of Biosphere Reserves in the Spanish Atlantic Region treasures a large number of unique components of the natural heritage and biodiversity because of their condition of biogeographical limit and transition with the Mediterranean territories. They house a remarkable richness of natural and semi-natural habitats that are threatened with disappearance in the whole of the European Union, or which have a very limited territorial representation within this territory (marshes, dune ecosystems, rivers, lagoons, peat bogs, wet heaths, coastal heaths, orophilic scrub, hay meadows, deciduous and evergreen endemic forests, rocky and slope vegetation, caves not exploited by tourism, etc.), as well as an important group of rare, endemic or considered threatened wild species and subspecies.

According to the distribution analysis of habitat types in the Iberian Peninsula (Ramil Rego et al. 2008a, b), the Biosphere Reserves in the Spanish Atlantic Region have been delimited on the areas that host a greater diversity of habitat types by 10x10 Km UTM grids (Figure 6). This motivates that the distribution of the number of habitats per grid within this set of Biosphere Reserves (Table 3) includes a higher proportion of the grid intervals with a greater number of habitats with respect to the rest of the Spanish Atlantic region, and even to the whole European Atlantic region, or the very European Union. The grid intervals with a lower number of habitats (10 types or less) are those that occur in the smallest proportion within the set of Biosphere Reserves in the Spanish Atlantic Region. On the contrary, the best represented intervals are those with a greater number of habitat types (more than 10 types). It is worth highlighting the interval with a greater variety of habitat types (> 30), which reaches a proportion that far exceeds 4-5 times that reached in the entire Atlantic Biogeographical region and even in the European Union. The 4 10x10 Km UTM squares with more than 30 habitat types are located in the coastal domain of Mariñas-Mandeo and Río Eo-Oscos-Burón Biosphere Reserves, due to the great diversity of the Atlantic coastal environments. In contrast, Urdaibai, Allariz and Gerês-Xurés Biosphere Reserves do not include grids of more than 20 habitat types. The remaining Biosphere Reserves are in an intermediate situation, hosting grids of up to 30 habitat types, although among them it is possible to identify grids with more than 25 habitat types in Ribeira Sacra, Muniellos, Somiedo, Babia and Ponga Reserves.



[1]: Mariñas-Mandeo; [2]: Terras do Miño; [3]: Río Eo-Oscos-Burón; [4]: Ancares Lucenses; [5]: Ancares Leoneses; [6]: Muniellos; [7]: Somiedo; [8]: Las Ubiñas-La Mesa; [9]: Valle de Laciana; [10]: Babia; [11]: Valles de Omaña y Luna; [12]: Alto Bernesga; [13]: Argüellos; [14]: Redes; [15]: Ponga; [16]: Picos de Europa; [17]: Urdaibai; [18]: Área de Allariz; [19]: Gerês-Xurés; [20]: Ribeira Sacra-Oribio-Courel.

Figure 6: Habitat richness per 10 x 10 km UTM grid of the Biosphere Reserves in the Spanish Atlantic Region. Prepared from Ramil-Rego et al. (2008a), EEA (2016) and MITECO (2021).

The territorial distribution of the Biosphere Reserves in the Spanish Atlantic Region over the areas that host greatest diversity of habitat types by UTM 10x10 Km grids (Figure 6) is directly proportional to the number of habitat types that each Biosphere Reserve houses (Table 2). Thus, the Biosphere Reserves with a greater number of habitat types are Mariñas Coruñesas e Terras do Mandeo (49 habitats) and Río Eo, Oscos e Terras de Burón (48 habitats), due to the presence in them of habitats sheltered in the littoral domain. Excluding the coastal Biosphere Reserves, Picos de Europa would be the area with the highest number of habitats of community interest (41 habitats), followed by Ribeira Sacra and Somiedo Biosphere Reserves (both 37 habitats). On the contrary, the Biosphere Reserves of Ponga and Area of Allariz are those that harbor in the Spanish Atlantic region a smaller number of types of habitats of Annex I of the Directive 92/43/EEC, with 19 and 13 types, respectively.

	EUROPEAN UNION		ATLANTIC REGION		SPANISH ATLANTIC REGION		SPANISH ATLANTIC BIOSPHERE RESERVES	
Nº hab	Nº LAEA	%	Nº LAEA	%	Nº LAEA	%	Nº UTM	%
≤ 5	17.511	32,5 %	7.541	57,9 %	286	30,4 %	10	3,8 %
6-10	15.350	28,5 %	2.695	20,7 %	149	15,8 %	54	20,7 %
11-20	18.238	33,8 %	2.377	18,3 %	341	36,3 %	135	51,7 %
21-30	2.578	4,8 %	371	2,8 %	144	15,3 %	58	22,2 %
> 30	200	0,4 %	35	0,3 %	21	2,2 %	4	1,6 %

Table 3: Comparison of the number of habitats per LAEA 10 x 10 km2 grid and percentages in the European Union, the Atlantic region, the Spanish Atlantic portion, and the Spanish Atlantic Biosphere Reserves. Prepared from EEA (2016, 2020b) and MITECO (2021).

Similarly, Mariñas Coruñesas e Terras do Mandeo and Río Eo, Oscos, Terras de Burón Reserves are the ones that host the largest set of priority habitat types, with a total of 12 priority habitats, due to the presence of coastal priority types that are not present in the rest of the Biosphere Reserves of the Spanish Atlantic Region. However, it is also worth highlighting the presence of 11 priority types in Ribeira Sacra, Terras do Miño and Os Ancares Lucenses, or 10 priority types in Picos de Europa and Valles de Omaña y Luna.

The set of Biosphere Reserves in the Spanish Atlantic Region house a set of 78 habitat types of community interest (Annex I, Directive 92/43/EEC), of which 19 are considered priority (Table 2). That is, the Spanish Atlantic Biosphere Reserves host 88% of the diversity of habitat types identified in the Spanish Atlantic region, and 64% of the diversity of habitats in the European Atlantic region (compare with Table 4). Regarding priority habitats, the Biosphere Reserves in the Spanish Atlantic Region play an even more important role: within this set of protected areas 100% of the types considered priority in the Spanish Atlantic region are included, and 63% of the diversity of priority habitats in Atlantic Europe (compare with Table 4).

	Number of habitat types		
	Total	**Priority**	**Non-priority**
European Atlantic Region	***121***	***30***	***91***
Spanish Atlantic Region	***89***	***19***	***70***

Table 4: Comparison of the number of habitats (priority and non-priority) of Annex I of Directive 92/43/EEC present in the European and Spanish Atlantic region. Taken from ETC/BD (2020).

Within all the diversity of identified habitats, it is possible to cite examples of habitat types that are widely distributed in all 20 Biosphere Reserves of the Spanish Atlantic Region, since they are characteristic habitats of the Spanish Atlantic landscape (Díaz González & Fernández Prieto 1994, Loidi et al. 1997). These types correspond to habitats linked to the Atlantic rivers (3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, 6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels, 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*), dry heaths (4030 European dry heaths) and deciduous oak forests (9230 Galicio-Portuguese oak woods with *Quercus robur* and *Quercus pyrenaica*).

However, the wide range of territories sheltered by the Spanish Atlantic Biosphere Reserves includes examples of habitats of great conservation value, which present high fragility and vulnerability due to a high fragmentation of their representations, such as habitats 2130* Fixed coastal dunes with vegetation herbaceous (grey dunes), 3170* Mediterranean temporary ponds, 4020* Temperate Atlantic wet heaths with *Erica ciliaris* and *Erica tetralix*, 7110* Active raised bogs, 7130* Blanket bogs, 7210* Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*, 91D0* Bog woodland, 9180* Tilio-Acerion forests of slopes, screes and ravines, 9560* Endemic forests with *Juniperus* spp., or 9580* Mediterranean *Taxus baccata* woods, among others.

With regard to specific diversity, the Ministry of Agriculture, Food, Fisheries and Environment (MAGRAMA 2015) has launched the Spanish Terrestrial Species Inventory (acronym in Spanish, IEET), which collects the geographical distribution of terrestrial fauna and flora in 10 x 10 km UTM grids. However, the information available in the IEET is uneven depending on the different groups of taxa. The areas with the highest specific diversity are closely related to the diversity of bird species (Figures 7 and 8), since some groups of species, such as flora or invertebrates, have been scarcely studied and are therefore underrepresented in the IEET.

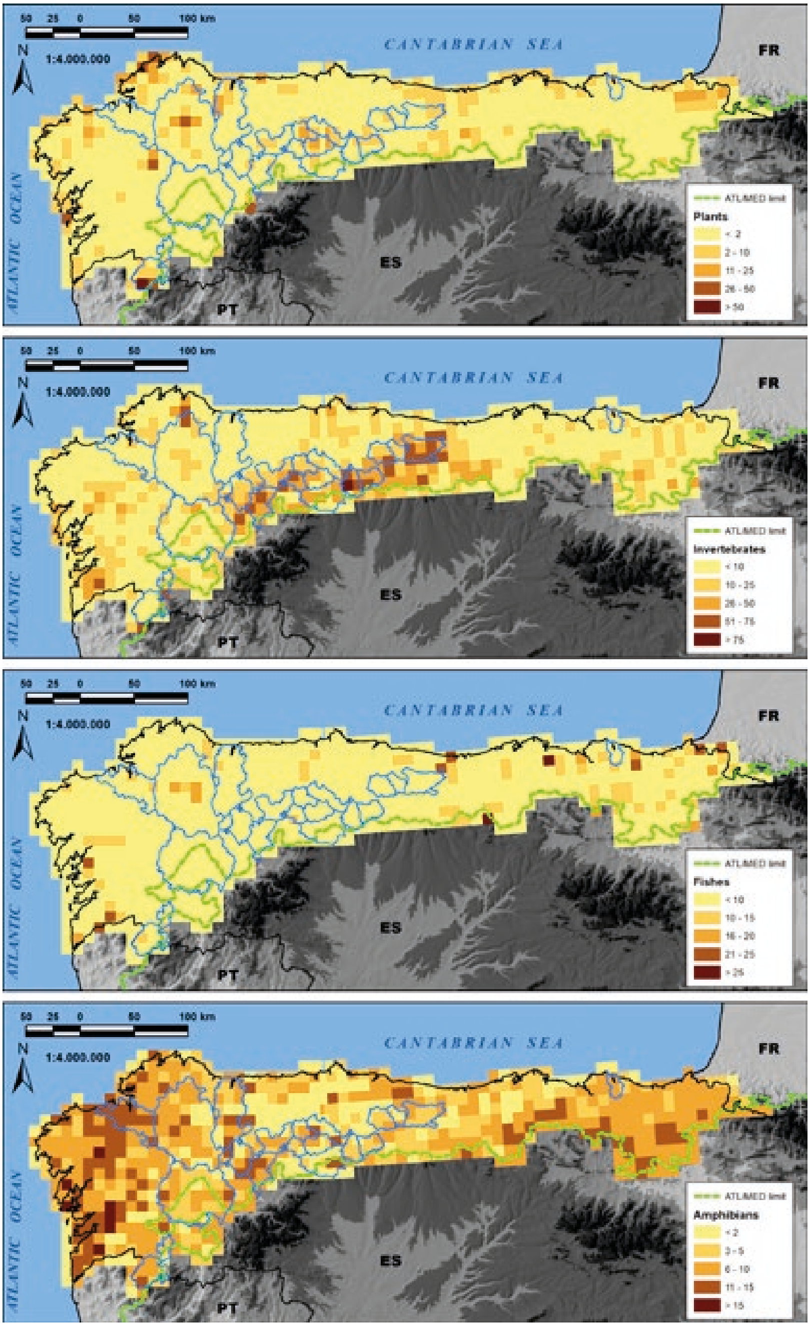


Figure 7: Comparison of species richness (plants, invertebrates, fish, amphibians) per 10x10 km UTM grid, according to data from the Spanish Terrestrial Species Inventory (MAGRAMA 2015).

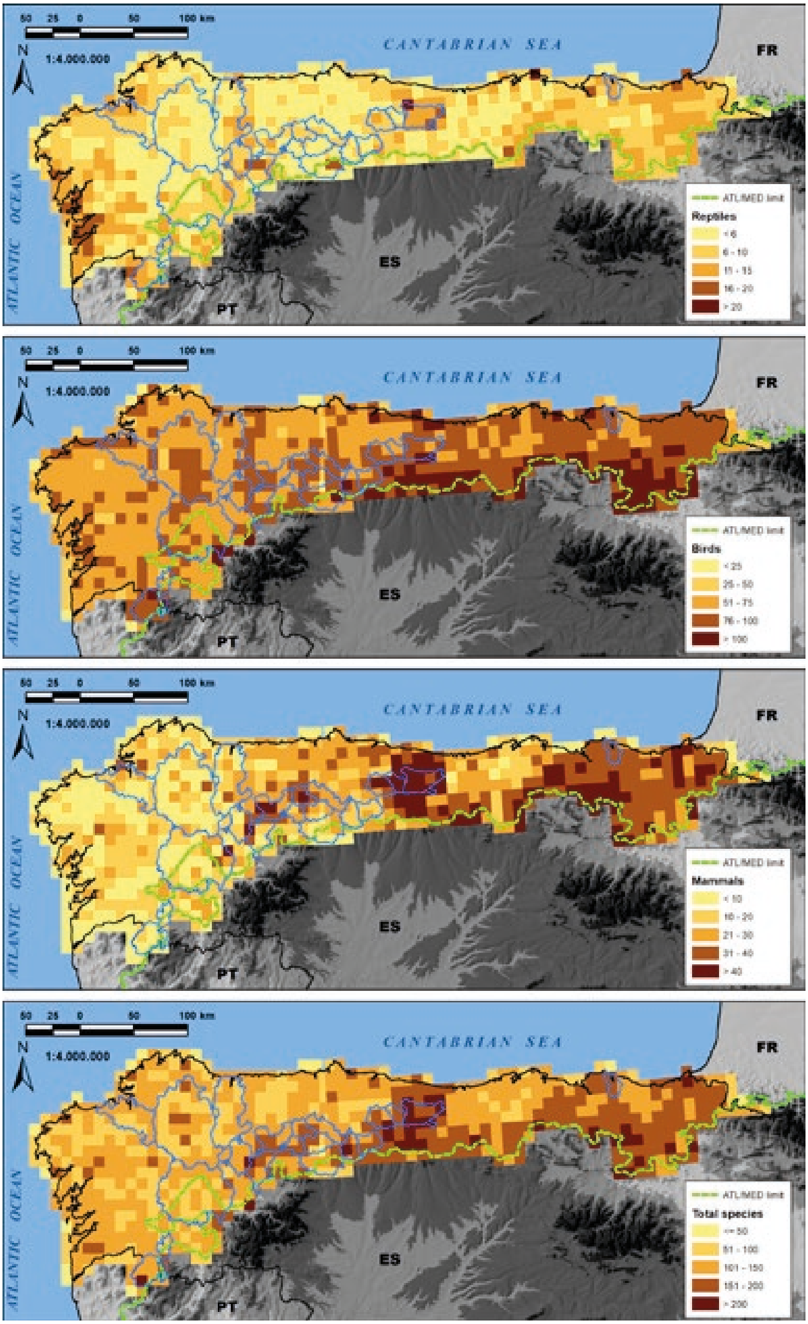


Figure 8: Comparison of species richness (reptiles, birds, mammals, total species) per 10x10 km UTM grid, according to data from the Spanish Terrestrial Species Inventory (MAGRAMA 2015).

The conservation of the species diversity, and specifically of species for biodiversity conservation interest, is regulated by the corresponding Annexes of EU Directives (92/43/EEC, 2009/147/EC), the Spanish Catalog on Threatened Species (Royal Decree 139/2011), and the respective regional catalogs of threatened species. The territorial assessment of all the protected and cataloged species within the scope of Spanish Atlantic Biosphere Reserves is tremendously complicated and expensive, since it would require the review of hundreds of scientific works, planning instruments, technical monographs and unpublished documentation that would exceed the objectives of the present work. However, Natura 2000 has meant the standardization the EU inventory of natural values, since through the corresponding Standard Data Forms (SDF) the present species of community interest (Annex II to Directive 92/43/EEC, Annex I to Directive 2009/147/EC) are registered for each Natura 2000 area, allowing a homogeneous treatment of the data stored in the database of the European Topic Center on Biological Diversity (ETC/BD 2021), dependent on the European Environment Agency (EEA). Taking into account that practically all the core areas of Spanish Atlantic Biosphere Reserves have been included within Natura 2000 Network, an analysis of their corresponding SDFs has been carried out, allowing a comparison in terms of species of community interest diversity that are present in each Biosphere Reserve.

In every Spanish Atlantic Biosphere Reserve, at least one flora taxon of community interest has been identified (Figure 9). The maximum is recorded in Gerês-Xurés Biosphere Reserve, with a total of 11 plant species, followed by Picos de Europa and Os Ancares Lucenses, located in the interval between 7 and 8 plant species. Among all the flora species of community interest present in Spanish Atlantic Biosphere Reserves, 3 priority taxa stand out: Eryngium viviparum*, Centaurium somedanum* and Aster pyrenaeus*.

Invertebrate fauna of community interest is also present in every Spanish Atlantic Biosphere Reserve (Figure 9). The maximum interval established, which is between 9 and 13 invertebrate species, is recorded in Ribeira Sacra, Picos de Europa and Río Eo-Oscos-Burón Biosphere Reserves. The presence of insects such as Oxygastra curtisii, Lucanus cervus, Cerambyx cerdo, Coenagrion mercuriale, Euphydryas aurinia or Macromia splendens, examples of mollusks such as Margaritifera margaritifera, Geomalacus maculosus or Elona quimperiana, or crustaceans like Austropotamobius pallipes, should be noted due to their high degree of threat.

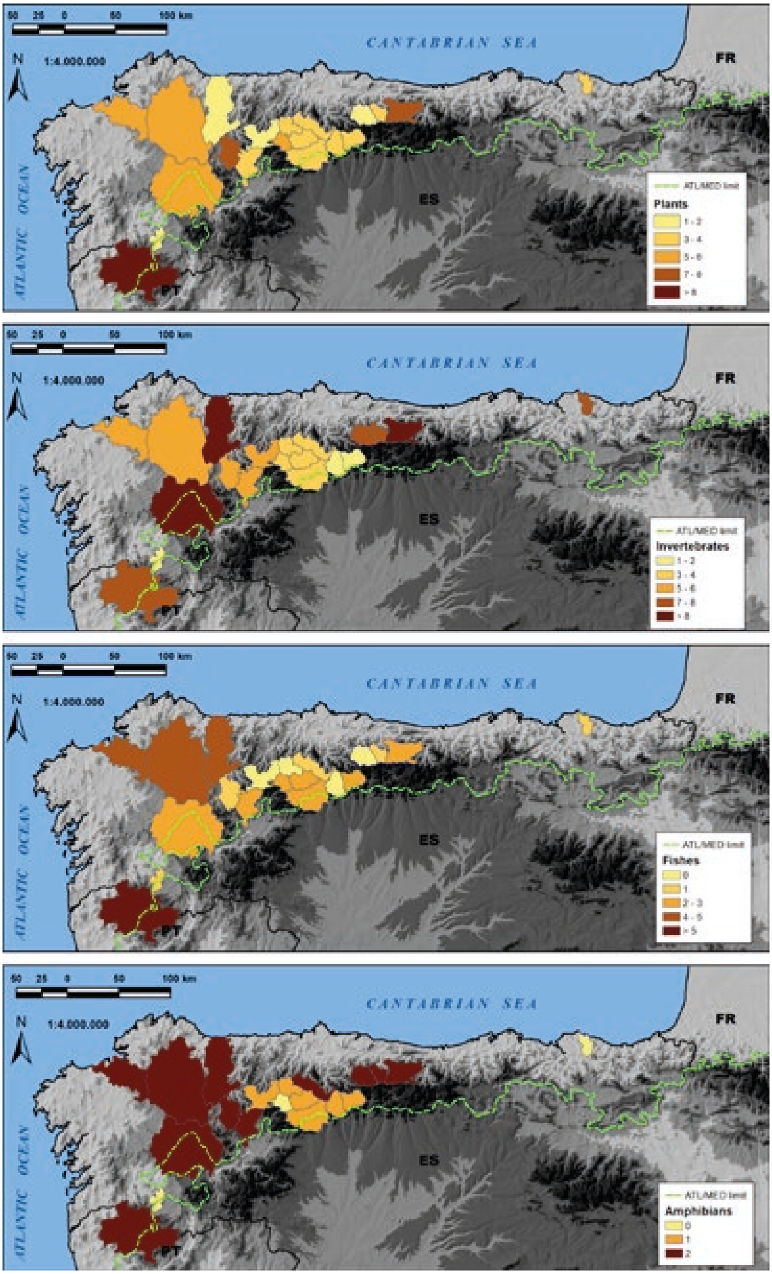


Figure 9: Number of species (plants, invertebrates, fishes, amphibians) of community interest for conservation that are present in the Natura 2000 areas of the Spanish Atlantic Biosphere Reserves. Prepared from ETC/BD (2021).

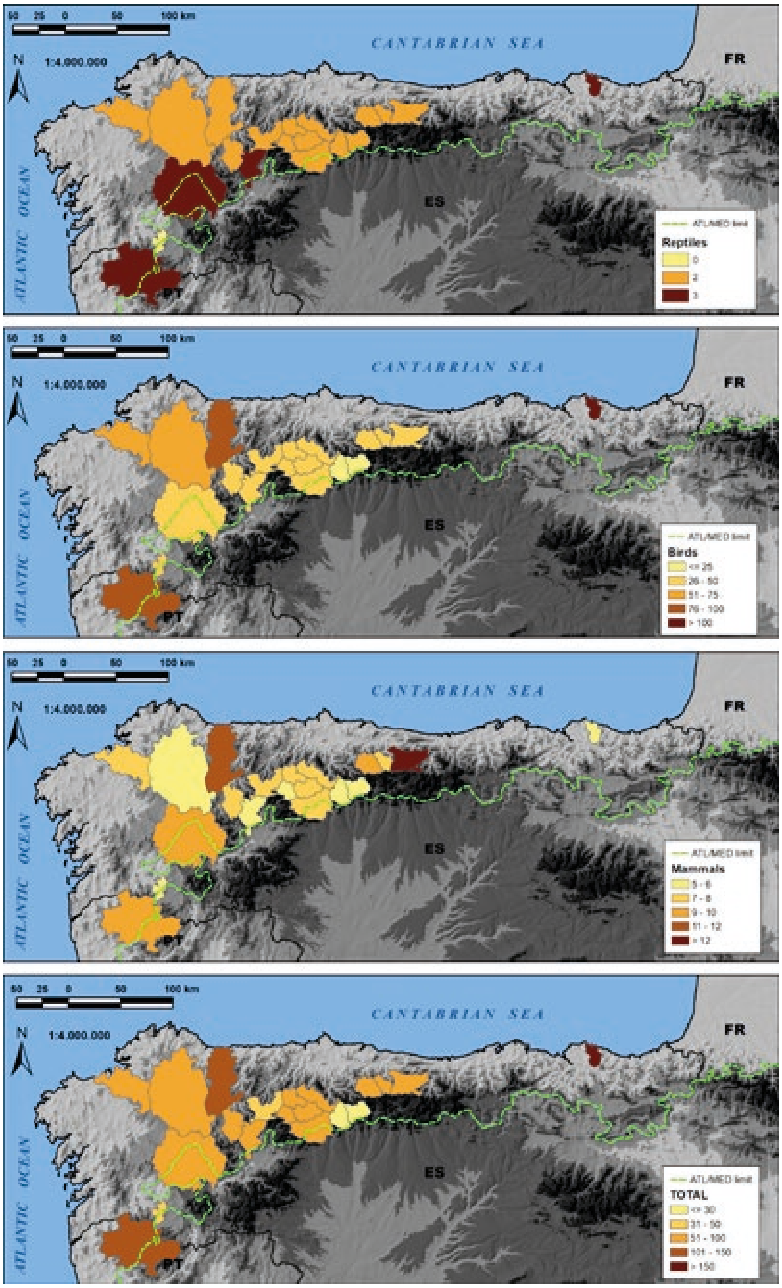


Figure 10: Number of species (reptiles, birds, mammals, total species) of community interest for conservation that are present in the Natura 2000 areas of the Spanish Atlantic Biosphere Reserves. Prepared from ETC/BD (2021).

With regard to fishes, some Biosphere Reserves host a high number of species of community interest, such as Gerês-Xurés that ranges between 6 and 7 fish species, or Mariñas-Mandeo, Terras do Miño and Río Eo-Oscos-Burón, where 4-5 community interest fish species have been inventoried (Figure 9). Among the threatened ichthyofauna species, it is possible to differentiate those with migratory habits such as *Petromyzon marinus*, *Salmo salar*, *Alosa alosa*, *A. fallax*, and continental fish species such as *Chondrostoma arcasii*, *C. duriense*, *C. miegii* or *Gasterosteus gymnurus*.

The total number of amphibian species of community interest present in the Spanish Atlantic Biosphere Reserves is lower than registered in the rest of the groups (Figure 9), since only *Chioglossa lusitanica* and *Discoglossus galganoi* are included in Annex II to Directive 92/43/EEC. Both species have been jointly identified in several Biosphere Reserves such as Mariñas-Mandeo, Terras do Miño, Río Eo-Oscos-Burón, Gerês-Xurés, Ancares Lucenses, Ancares Leoneses, Las Ubiñas-La Mesa, Redes and Picos de Europa.

Reptile species of community interest also have a low set of species (Figure 10). It is possible to differentiate the species of marine habits from the continental taxa. Among the first ones, their presence is reduced to Biosphere Reserves including marine ecosystems (Mariñas-Mandeo, Río Eo-Oscos-Burón, Urdaibai), being possible to highlight the presence of two sea turtle priority species, *Caretta caretta** and *Chelonia mydas**. Among the terrestrial reptiles it is possible to mention the presence of *Iberolacerta monticola* or *Lacerta schreiberi*, present in Ribeira Sacra, Gerês-Xurés and Ancares Leoneses.

The group of birds of community interest, included in Annex I to Directive 2009/147/EC, represents a larger list than identified in the rest of the groups. Its highest levels of diversity are related to coastal or sub-coastal Biosphere Reserves (Figure 10). It is worth highlighting Urdaibai Biosphere Reserve, where more than 150 bird species of community interest have been identified, followed by Río Eo-Oscos-Burón and Gerês-Xurés, which house between 76 and 100 bird species, while in Mariñas-Mandeo and Terras do Miño the values are between 50 and 75 bird species of community interest. Among the different identified bird species, it should be noted the presence of the capercaillie, *Tetrao urogallus*, in addition to many others such as *Aquila chrysaetos*, *Botaurus stellaris*, *Bubo bubo*, *Burhinus oedicnemus*, *Charadrius alexandrinus*, *Circus cyaneus*, *Circus pygargus*, *Gypaetus barbatusetus*, *Gypaetus barbatus*, *Gypaetus fascia*, *Himantopus himantopus*, *Ixobrychus minutus*, *Luscinia svecica*, *Milvus milvus*, *Neophron percnopterus*, *Perdix perdix hispaniensis*, *Pyrrhocorax pyrrhocorax* or *Tetrax tetrax*, among many others.

The presence of mammal species of community interest in the Spanish Atlantic Biosphere Reserves is highly correlated with mountainous areas (Figure 10). Picos de Europa Biosphere Reserve houses the largest group of mammals with a total of 13 identified species. Ribeira Sacra, Río Eo-Oscos-Burón, Redes and Gerês-Xurés, are equally remarkable, registering between 9 and 12 mammal species of community interest. Among the different species of mammals, it is worth highlighting the presence of the brown bear, *Ursus arctos**, a priority species according to Directrive 92/43/EEC. The rest of mammal species of community interest belong mainly to the Chiroptera group, with examples such as *Miniopterus schreibersii*, *Myotis emarginata*, *M. blythii*, *M. myotis*, *Rhinolophus euryale*, *Rhinolophus ferrumequinum* or *Rhinolophus hipposideros*, among many others. Also noteworthy is the presence of aquatic mammals, such as *Galemys pyrenaicus* and *Lutra lutra*, which play an important role in maintaining the functionality and essential processes of ecosystems.

5. New projects and initiatives in the Spanish Atlantic Biosphere Reserves

Spanish Atlantic region is one of the European areas that has the greatest value for EU biodiversity conservation, including a large set of habitat types and species considered of interest for conservation under the European Directives 92/43/EEC and DC 2009/147/CE. This has led to the delimitation of a profuse Natura 2000 Network, which have served as support for the core areas of the set of Biosphere Reserves in the Spanish Atlantic Region. The synergy created between the importance of the natural values housed and these new instruments for the protection, planning and management of biodiversity, have made possible the implementation of new projects and initiatives for nature conservation and sustainable development in this territory, fundamentally through the LIFE program (EC 2021b).

In 2001, the first Biosphere Reserve was declared in Galicia region. It was called Terras do Miño, and was committed to promoting a new territorial model, based on the interaction of "Sustainable Rural Development" and "Conservation of Biodiversity" (Crecente Maseda & Ramil-Rego 2000). Terras do Miño occupies its 363,669 ha (10% core area), representing 39% of the Lugo province area. To materialize this new Biosphere Reserve, a new LIFE-Nature project was applied and finally approved, entitled "SCI Parga-Ladra-Támoga: recovery of bog woodland and dystrophic lake" (LIFE00 NAT/E/007330), and it was executed between 2001-2006, which included as a novelty the first purchase of private land to be used for conservation by a public administration (in this case, the province government). After the land acquisition, different ecological restoration actions were developed on San Roque Fluvial Island and Ollos de Begonte lagoons. Behind these initiatives was a group of professors from the University of Santiago de Compostela, young researchers and technicians from the regional and provincial governments. Rafa Crecente was the alma mater of this LIFE project, so we had the pleasure of sharing with him many and endearing moments.

LIFE Parga-Ladra-Támoga (LIFE00 NAT/E/007330) project actions generated a huge knowledge about the implementation of new conservation initiatives, so they were later continued by LIFE TREMEDAL project (LIFE11 NAT/ES/000707), which has been developed in Terras do Miño and Picos de Europe Biosphere Reserves. In both cases, restoration actions have been carried out on peat bog habitat types (7110*, 7130*, 7140, 7150, 7210*, 7230) and on other types of wetlands (3110, 6510, 91E0*), as well as on the considered taxa for biodiversity conservation interest they harbor, with special attention to the priority species *Eryngium viviparum**, and others such as *Spiranthes aestivalis* or *Narcissus pseudonarcissus nobilis*.

This kind of projects are of great interest not only because of the environmental benefits they produce, but also because they allow to increase knowledge and development of capacities, since they generate up-to-date and homogeneous information on the distribution and conservation status of humid heaths and peat bogs that are considered key elements for biodiversity (Ferreiro da Costa et al. 2013; Ramil-Rego & Rodríguez Guitián 2017; Ramil-Rego et al. 2017, 2018) collecting experiences for their better management and restoration (Berastegi et al. 2016). In a complementary way, the information generated allows to improve and increase the sensitization and awareness of society about the environmental values and ecosystem services that provide the key elements for the conservation of biodiversity, and specifically the habitat types and species of interest for conservation.

Forest ecosystems have also been the subject of various LIFE projects in Spanish Atlantic Biosphere Reserves, highlighting the LIFE BACCATA project (LIFE15 NAT/ES/000790), which seeks to improve the conservation status of yew (*Taxus baccata*) forests, considered a priority habitat type (9580*), which has a scarce distribution in the European Union, and which is present in the Spanish Atlantic region. The territorial scope of LIFE BACCATA is divided into 15 Natura 2000 SACs of the Cantabrian Mountains, which are present in 7 different Biosphere Reserves: Ancares Leoneses, Valle de Laciana, Babia, Valles de Omaña y Luna, Alto Bernesga, Los Argüellos and Picos de Europa. The relevance of this project is high, since it has been proposed to increase the area of occupation of this habitat type by 7%, and an improvement of conservation status (Figure 11) by 26%, complemented by a genetic characterization of *Taxus baccata* in the Spanish Atlantic region, which has determined the variability and degree of genetic connectivity between yew populations, as well as the kinship structure (Maroso et al. 2021). The dissemination, sensitization and awareness of society about the conservation of forests in general, and of yew forests in particular, is also encompassed within LIFE BACCATA, together with the transfer of the project results for their replicability to the different involved stakeholders throughout Spain and the European Union.

River corridors have been the main goal of an ambitious transnational strategy to improve their conservation status, through LIFE FLUVIAL project (LIFE16 NAT/ES/000771). This project is being developed in 9 Natura 2000 areas from Galicia, Asturias and Northern Portugal, including action sites in the upper, middle and lower basins of Eo, Miño, Mero-Barcés, Mandeo and Lima rivers (Figure 12). The targeted habitats (91E0*, 9230) are the object of concrete conservation actions through the elimination of forest plantations of *Eucalyptus globulus*, the eradication and control of invasive species (*Cortaderia selloana*, *Crocosmia x crocosmiiflora*, *Robinia pseudoacacia*, *Populus* spp., *Erigeron canadensis*, *Delairea odorata*, etc.), the naturalization of grey infrastructures established in the river corridors, and the restoration of natural habitat types by planting their characteristic species using local and compatible reproduction material (Marquínez et al. 2019). The project has arisen from the synergies established by 3 Spanish Biosphere Reserves of the Atlantic region (Mariñas-Mandeo, Terras do Miño, Río Eo-Oscos-Burón), which actively participate in the project as associated beneficiaries through the implementation of conservation and dissemination actions that are included in the project.

In other cases, conservation projects have focused on considered taxa for biodiversity conservation interest, with special attention to those considered endangered. In this case, there is no doubt that in the Cantabrian Mountains the species that have received the greatest research and conservation efforts are the brown bear (*Ursus arctos**) and the capercaillie (*Tetrao urogallus*).

Figure 11: Herbivory exclusion plots of LIFE BACCATA to favor the regeneration of Taxus baccata in Los Argüellos Biosphere Reserve.

Figure 12: Fluvial section of the Parga River, in the upper basin of Miño river (Terras do Miño Biosphere Reserve), which has been the object of LIFE FLUVIAL conservation actions.

The territorial scope formed by a high proportion of the Spanish Atlantic Biosphere Reserves (Río Eo-Oscos-Burón, Os Ancares Lucenses, Los Ancares Leoneses, Muniellos, Somiedo, Valle de Laciana, Babia, Valles de Omaña and Luna, Las Ubiñas-La Mesa, Alto Bernesga, Los Argüellos, Redes and Picos de Europa) forms a continuum in which various instruments and actions have been implemented for the conservation of *Ursus arctos**. These instruments and initiatives include the development of population monitoring of the brown bear and actions to improve its habitat, through various LIFE projects that have been developed in recent decades (CORREDORES OSO, OSO/CANTABRIA, OSO/GALICIA, BEAR IN ASTURIAS, LIFE BEAR DEFRAGMENTATION, etc.). The initiative for the implementation of these projects arose from the provision of the Spanish Strategy for the Conservation of Brown Bear (MMA 1999). However, new projects were also started seeking synergy between the conservation of the brown bear and other aspects such as climate change ("Osos CO2") or conservation of insects ("Abejas en Acción"). In a complementary way, support for the maintenance of mountain livestock has been provided from the different regional governments where the species is present.

Capercaillie (*Tetrao urogallus*) has been the object of a conservation strategy parallel to brown bear's, since its presence is distributed in the same Biosphere Reserves as the plantigrade, sharing in some cases programs and actions of conservation (LIFE ANCARES/GALICIA and LIFE ANCARES/CASTILLA Y LEÓN) that were designed in a coordinated and complementary way, although capercaillie has had its own projects (LIFE UROGALLO CANTABRICO). All these projects have pursued the improvement of capercaillie's habitat in the Cantabrian Mountains, the reintroduction of the species in areas where it had disappeared, and have been complemented with aids for the maintenance of mountain livestock.

In addition to the above habitats and species, other examples have been the subject of LIFE projects in the Spanish Atlantic region, as a sign of the extraordinary biodiversity housed in this territory, and in response to its high variety of ecosystems. Thus, dune ecosystems (2110, 2120, 2130*) have also been the object of LIFE projects (LIFE + ARCOS, LIFE DUNAS LAIDA), while various considered taxa for biodiversity conservation interest have also been the main beneficiaries of several LIFE projects, as *Galemys pyrenaicus* (LIFE DESMANIA), *Margaritifera margaritifera* (LIFE MARGAL-ULLA), or *Woodwardia radicans* (LIFE MIERA), among many others.

However, despite the implementation of all these sustainable use initiatives that lead to projects of great environmental value, and that are complemented by the promotion of products of great cultural and economic value, it should be noted that some sustainable practices are being abandoned over time, or instead they are transformed into intensive practices that generate no- natural value scenarios. The persistence of these practices causes a loss of biodiversity derived from landscape homogenization that is instigated by the establishment of intensive agrosystems (artificial pasturelands) and intensive forest plantations with exotic species (*Pinus*, *Eucalyptus*), as well as the profusion of invasive alien species, or the establishment of grey infrastructures of no- natural value.

In some Spanish Atlantic Biosphere Reserves, such as Terras do Miño, Mariñas-Mandeo, Ancares Lucenses, Río Eo-Oscos-Burón or Gerès-Xurés, the abandonment of sustainable practices that are replaced by intensive activities have produced notable biodiversity problems in recent decades, both in core areas and outside of them (Ramil-Rego et al. 2013, 2017), causing a loss of natural habitats such as dry heaths, wet heaths and peatland ecosystems. In other cases, such as in Valle de Laciana, Babia or Alto Bernesga Biosphere Reserves, open-pit coal mining has been carried out in a way that is incompatible with the maintenance of a favourable conservation status of considered species for biodiversity conservation interest (Naves et al. 2003) such as the brown bear (*Ursus arctos**) or the capercaillie (*Tetrao urogallus*), causing habitat destruction and loss of connectivity, as well as generating an important social conflict with the different involved sectors and agents (Herrero Cabrejas 2013).

Tourism is a growing problem, especially considering that the management of public use is one of the pending subjects in Spanish protected areas, where lifts or recreational infrastructures are installed (Ramil-Rego & Ferreiro da Costa 2015) on ecosystems of great conservation value (dunes, river corridors). The uncontrolled profusion of visitors is usually associated with the appearance and massive colonization of natural ecosystems by invasive alien species (Ramil-Rego et al. 2019, Fernández-Bouzas et al. 2019).

It is also worth highlighting the ugliness as a distorting element and loss of quality of the landscape, which currently causes a significant effect both in natural protected areas and outside them (Ramil-Rego & Ferreiro da Costa 2015). Often the supposed improvement actions against ugliness by public administrations or by individuals do not allow to solve the identified problems, aggravating them in most of the cases.

6. Final considerations

The Atlantic part of Spain is one of the most biodiverse areas of the entire Atlantic biogeographical region, and even of the whole European Union, as it includes a significant proportion of all habitat types in the European Atlantic region. This has favoured the establishment of a profuse set of Biosphere Reserves into the Spanish Atlantic region, which constitute an extensive group of territories in which initiatives are launched for the conservation of biodiversity, sustainable development and the improvement of knowledge and the capacities of the population.

The privileged situation of the Spanish Atlantic Biosphere Reserves has allowed the development and implementation of an important set of initiatives for the conservation and restoration of habitats and populations of species of biodiversity conservation interest. Consequently, the Spanish Atlantic Biosphere Reserves have become benchmark areas to implementing new strategies, functioning as living laboratories where to develop and test new experiences of biodiversity conservation, the promotion of sustainable development, and logistical support for research, monitoring, education and information exchange.

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The value of rural Galician land in the context of fragmented property. Implications for land management.

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Summary:
The term fragmented property refers both to the existence of a large number of landowners and to an excessive amount of parcelling. In general, the two aspects go hand in hand and the case of Galician soils is no exception. However, for land valuation purposes, the most important factor is the size of the property.
For valuation of more than 93% of the land in Galicia, two methods must be used: the comparison method and the updated revenue method. In principle, when applying both methods, the size of the property to be appraised must be taken into account, which influences the result obtained. However, this has not been nor is it the case, in the so-called administrative valuations (fiscal, expropriation), where equal unit values are used for properties that differ only in their size, even when this difference is enormous.
Thus, for the purposes of expropriation, neither expropriators nor beneficiaries have reflected these distinctions in their valuations, placing importance instead on the number of times that the expropriation has included –with the backing of expropriation juries and courts - what they have called "compensation for partial expropriation." This is done to compensate for the damage caused to the part of the property not expropriated, as a consequence of the fact that when the surface area of a property decreases, the unit costs of exploitation increase. There have also been numerous incidences where juries have been obliged to include this compensation as a consequence of the non-acceptance, by the administration, of the owner's request that the entire property be expropriated.
The inclusion of this type of compensation clashes head-on with the fact that the surface area of the plot is not taken into account when the unit value is calculated, so it is clear that there are compelling reasons for maintaining this inconsistency.
At present, in the vast majority of expropriation valuations (of land in rural areas), the updated revenue method must be used, as explained in the revised text of the Law on Land and Urban Renewal,

approved by Royal Legislative Decree 7/2015 of 30 October. For the application of this method, some factors besides the size of the property will have a greater influence on the unit value obtained. The main factors are the confusion between exploitation income and land income, the excessive variation in the type of capitalization to be used (less important recently), and the lack of a clear interpretation of the correction factor by location. When applying this method, it must be kept in mind that the valuation of a rural land property is the greater of the two values obtained by either: updating the revenue with the existing land use or using the maximum potential benefit, carried out by the average farmer. With this form of calculation, the state legislator provides a solution for land properties in communities like Galicia where, the productive capacity of the land often does not even remotely correspond with the real production. The legislator thus indirectly recognizes the existence of a problem of underutilization of the land. At the same time, this highlights another hurdle that valuators in Galicia must overcome: the lack of a map of productive capacities of the soil on a sufficient scale and covering the entire autonomous community. Regarding potential income, in the face of an expropriation valuation that would take into consideration a property's small size and therefore its reduced unit value, the expropriated party could always argue that it would "potentially" be possible to exploit the land in conjunction with the neighbouring parcels, if plots of land with an optimum surface area for this purpose were obtained. There is little to counter this reasoning, which is why I believe that in order to calculate potential income it is necessary to act in this way, even though management costs would have to be charged for such joint exploitation.

The state legislator's reasoning leads to the conclusion that the real problem facing land management in Galicia is not land fragmentation but the existence of underutilized and idle land. It is true that fragmentation is often the root cause of land idleness, but idleness could also be fought via other mechanisms besides those aimed at defragmentation (which are no doubt the main mechanisms), making space also for the possibility of so-called "sustainable small farms" or the joint use of land (either by jointly assuming the risks or by leasing).

1. Fragmented property. Many owners and small plots

1.1. The expression "fragmented property"

The expression fragmented property refers both to the existence of a large number of owners and to the existence of an excessive number of parcels. Today in Galicia we have both problems, which almost always and nearly every where in the world go together.

1.2. Fragmented property and valuation

From the point of view of land valuation, which is considered synonymous with appraisal, or "calculation of a value," and not with the academic meaning of "value given," the number of owners is almost irrelevant (this does not happen in the case of management), but the number of plots is very important.

Thus, in this article I will take fragmented property to mean small-sized plots, which in terms of valuation is the biggest problem of fragmentation, since at least theoretically, a large number of owners does not necessarily mean a small exploitation unit (large companies have many "owners"), nor even does small exploitation - encompassing little territory–necessarily mean an unviable or uneconomic enterprise.

2. Land valuation. Influence of the size of the property to be valued and how this is reflected in administrative valuations

2.1. Main valuation methods used in land valuation

For valuation of more than 93 % of the 29,574 km2 of the land in Galicia, two main methods must be used: the comparison method and updated revenue method. With the first a "market value" is obtained, and with the second a "value by update" is obtained. The latter value does not necessarily have to coincide with the market value.

Either one method or the other is used depending on the end purpose of the appraisal. This means that by taking the reason for the appraisal into account, different values can be obtained for the same property: market value, cadastral, urban planning, expropriation, registration, mortgage, etc. In practice, this situation has consecrated the "principle of purpose," a principle that seems to contradict the rest of the valuation principles.[5]

This plurality of values is difficult to justify. For example, in order to understand why for a property that is expropriated, a lower-than-market price is paid, one must interpret Article 33.3 of the Spanish Constitution,[6] taking "corresponding compensation" to mean "legal compensation" and not "fair compensation, that would enable the purchase of an analogous property on the market."

2.2. Theoretical influence of property size on its unit value

In principle, in the application of both methods, the size of the property to be valued must be taken into account, affecting the result obtained. However, the size affects the value obtained either negatively or positively depending on which

5. The so-called "principle of purpose" is the justification for the proliferation of administrative appraisals. Administrative values can be modified according to economic, political, social, expropriation and urban criteria, etc. and are only valid for their specific purpose. Administrative values are not always market values.

6. Article 33.3 of the Spanish Constitution: No one may be deprived of his or her property or rights except for a justified cause of public utility or social interest, by means of the corresponding compensation and in accordance with the provisions of the law.

method is used. Normally, by comparison, the unitary values of land are greater for smaller properties, and by updated revenue, the opposite is true.

In general, it is clear that in the case of a small property, if its owner wishes to sell it, he either sells it for a lump sum of money or he doesn't sell it. It is quite possible that the only possible buyer for that property will be a neighbour (there is no real market for this type of goods), who will also pay more attention to the total amount of the transaction than to the unit value. However, if the object for sale is a property of considerable size, the market is more open, and the situation changes considerably. Here, the unit value becomes more important.

On the other hand, if we think of the economic yield that can be obtained from a farm, in the case of a very small farm, the unit cost of growing is higher and therefore the net yield is lower. There is also a minimum area, which depends on which crop is to be grown, for the viability of a farm. If the farm is too small, it is not viable.

2.3. Reflection of property size in administrative appraisals

To date, these disparities have not been reflected in the so-called administrative valuations (fiscal, expropriation), and equal unit values are only used for properties differing in size, even if this difference is enormous. Nor is this expected to change.

This applies, for example, to valuations for the payment of real estate taxes, where the tax base is a function of the cadastral value. The cadastre does not take property size into account, but the valuations it makes are quite different from market values. On the other hand, for example, the tax office does not take property size into account either, although in principle it works with market values.

3. The case of expropriation valuations

3.1. The incongruence: unitary value of land independent of property size, but legal compensation for partial expropriation of agricultural land.

Due to my professional activities over the course of my lifetime, the case that I know best is that of expropriation valuations. In this field, neither expropriators nor beneficiaries have reflected different unitary values of land based on the size of the properties in their valuations, placing importance instead on the number of times that the expropriation has included - and expropriation juries and courts have backed this - what they have come to call "compensation for partial expropriation". This is to compensate either for the loss of a former use of the land or for the damage caused to the not-expropriated part of the property, as a consequence of the fact that when the surface area decreases, the unit costs of exploitation increase. There have also been numerous incidences where juries have been obliged to include this compensation as a consequence of the non-acceptance, by the administration, of the owner's request that the expropriation encompass the entire property.[7]

An example will serve us to better understand the concept of "compensation for partial expropriation": If on a farm of 100 surface units (SU) annual benefits of 100 monetary units (MU) are obtained, and if 1 SU is expropriated and from the remaining 99 SU benefits of 99 MU are obtained, no is compensation necessary, unless 99 SU does not allow for a use that is possible with 100 SU. If, however, 99 SU are expropriated, it is quite possible that only 0.1 MU of the profit be made (instead of 1 MU), or may even possible that exploiting the remaining 1 SU is not economically profitable. In this case it is clear that compensation would be required, and a great deal (almost 100% of the value of 1 SU). Between these two extremes lie an infinite number of other situations.

The inclusion of this type of compensation clashes head-on with the fact that the surface area of the property is not taken into account when the unit value is calculated, so it is clear that there are compelling reasons to maintain the inconsistency.

The following are some possible reasons why the beneficiary and the valuations of expropriation may not reflect different unit values, taking into account the size of the property to be valued:

A) The ease of valuation - valuations are usually carried out according to the existing crop on the property, under the assumption that the same crop yields identical value, because it is deemed that the crop represents the productive aptitude of the land.[8] B) The method preferred by the applicable legislation for the valuation of agricultural soils changed with The Law on Land and Urban Renewal,[9] so that the influence of the size of the property is different than it was. C) Sometimes farms have to be segregated in the middle of the expropriation

7. Art. 23 of the Law of Forced Expropriation of 16 December, 1954 (LEF) in relation to art. 46 of the same legal text.

8. Those who are familiar with the Galician countryside know that this may have been so in 1960, but not today.

9. The revised text of the Law on Land and Urban Renewal, approved by Royal Legislative Decree 7/2015 of 30 October, applies to files with a declaration of need for occupation after1July, 2007. Law 6/98, of 13 April, on the regime of land and valuations, which prefers the comparison method and only contemplates the updated income method as a substitute, in the event that the comparison method cannot be used, is applied to files with a declaration of need for previous occupation.

procedure, meaning that their unit values would have to be modified. D) It would imply admitting that compensation was due in cases of remains of the properties. E) In some cases, the total area of the partially expropriated property is unknown.

3.2. Parameters to take into account in the valuation of damages due to partial expropriation of agricultural land.

Some valuers believe that the damages caused in the non-expropriated part of a rustic property are dependent on the surface area of the expropriated part, a relationship that in my opinion makes no sense, so I will make no effort to refute it.

Nor does it seem logical to me to tax the land at a fixed percentage of the value of the non-expropriated part, without taking into account the initial and final surface areas. This is what is advocated for by many law experts who value the land at between 10% and 30%, but it is clear that this provides a single solution for many different cases. With this method, the damage caused, by the expropriation of a small area in relation to the whole property, would be overestimated.

Nor do I see it as fair or legal to ignore the loss of uses or other capacities of a property due to the reduction in its surface area, unless legislation prevents this,[10] in which case it would be legal. I understand that before the Royal Decree 1492/2011 of 24 October entered into effect, approving the valuation regulations of the Land Law (RVLS), some square metres were more valuable than others.[11] With the application of the aforementioned law, the owners of two estates from which analogous areas, one of 4.000 m2 and another of 3.999 m2, were expropriated would be compensated equally when the first, due to the urban development regulations in effect in Galicia at the time,[12] would lose the possibility of building a house on the land while the second one would not.

Thus, it seems clear to me that the damage caused by a partial expropriation of a property, as described in the previous point, depends, at the very least, on the surface area of the property before the expropriation and on its size afterwards. It

10. In the case of expropriation valuations, this is what, in my opinion, the Valuation Regulations of the Land Law (RVLS), approved by Royal Decree 1492/2011, of 24 October, do in article 7.5:"In no case foreseen in this article can expectations be considered that are derived from assigning building rights and territorial or urban planning uses that have not yet been effectively carried out."

11. And today, if we value for a purpose to which the RVLS is not applicable.

12. Law 9/2002 of 30 December, on urban planning and protection of the rural environment of Galicia, modified among others by the Law 2/2010, of 25 March, of urgent measures of modification of the Law 9/2002. Today, with the Law 2/2016, of 10 February, on the land of Galicia, the minimum surface area required for authorization of a rustic property for construction is 2,000 m2 also depended, until the RVL Sentered into effect, on the uses that were allowed before the expropriation but not afterwards. In this way, any model proposed for the quantification of compensation must, in my opinion, include these variables.

3.3. Models for the valuation of damages due to partial expropriation of agricultural land.[13]

The fundamental problem for the proposal of a stable valuation model is the excessive frequency with which the applicable legislation changes. For example, with the LOUG,[14] from 01/01/2003 to 20/04/2010, building a sawmill on a plot of less than 5,000 m2 was not permitted. After the second date, the limit was reduced to 3,000 m2 and in the Law 2/2016 on the land of Galicia, of 10 February, these parameters changed again.[15] As I mentioned earlier, beginning on 10/11/2011, when the RVLS went into effect, potential but not-realized uses of the land cannot be taken into account in the appraisal. Thus, the model will be valid for one certain legislation and will have to be adapted to cater to any amendments that are made to the law.

In any case, regardless of the model implemented, it is essential to determine an area for which the operating costs per square metre are practically identical. This does not depend on the applicable legislation, but on the crop and the soil that can support it. In the first draft of the LOUG we saw a hint of this, because somehow the legislator mandated that division of a farm could not leave individual plots smaller than 15,000 m2 and believed that on farms of more than 15,000 m2, with similar characteristics, the operating costs per square metre would be virtually identical.[16] This reasoning, which is based on the assumption that this minimum surface area is independent of the crop (when in fact it has only extensive crops in mind), would lead us to not compensate for damages due to partial expropriations in cases where the resulting plots were larger than 15,000 m2, since these would not exist (let's not confuse compensation for partial expropriation with compensation for the division of a farm).

13. I limit the subject to farms of an agricultural nature because each category of rural land would have its own unitary devaluation curve.

14. Law, 9/2002 of 30 December, of urban planning and protection of the rural environment of Galicia, modified among others by the Law 2/2010, of 25 March, of urgent measures of modification of the Law 9/2002.

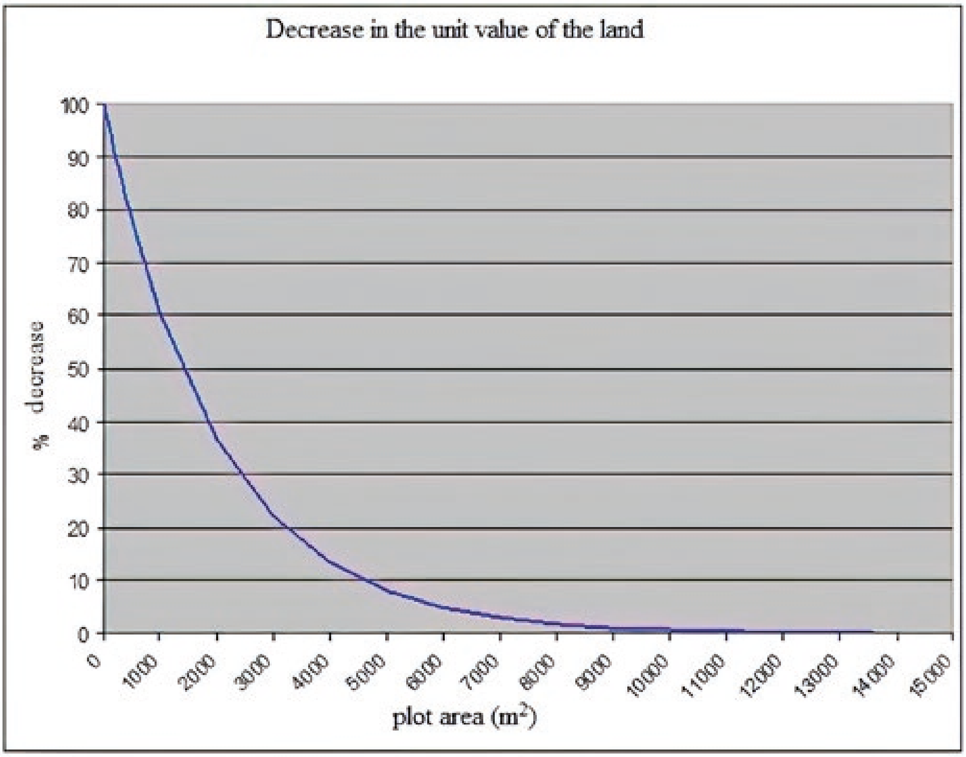
15. Almost all the modifications have reversed the path laid out in the first draft of the LOUG, which had been very difficult to draft.

16. Art 206 LOUG in its wording until 20/04/2010.

Supposing that the value of the land only has an agricultural component and forgetting about "jumps" in its value due to uses and other circumstances, once a minimum surface area (15,000 m2) has been fixed, below which damages due to increased unit costs must be considered, how would a property's unit value decrease with the decrease in the surface area of the property to which it belongs? It seems logical that it should be proportional to the increase in production costs, or better yet to the decrease in net yields. Accepting that the unit value of the land is proportional to the agricultural revenue that it can produce, we can calculate the compensation in question as the difference between the agricultural revenue from the land and that of a 15,000 m2 farm.

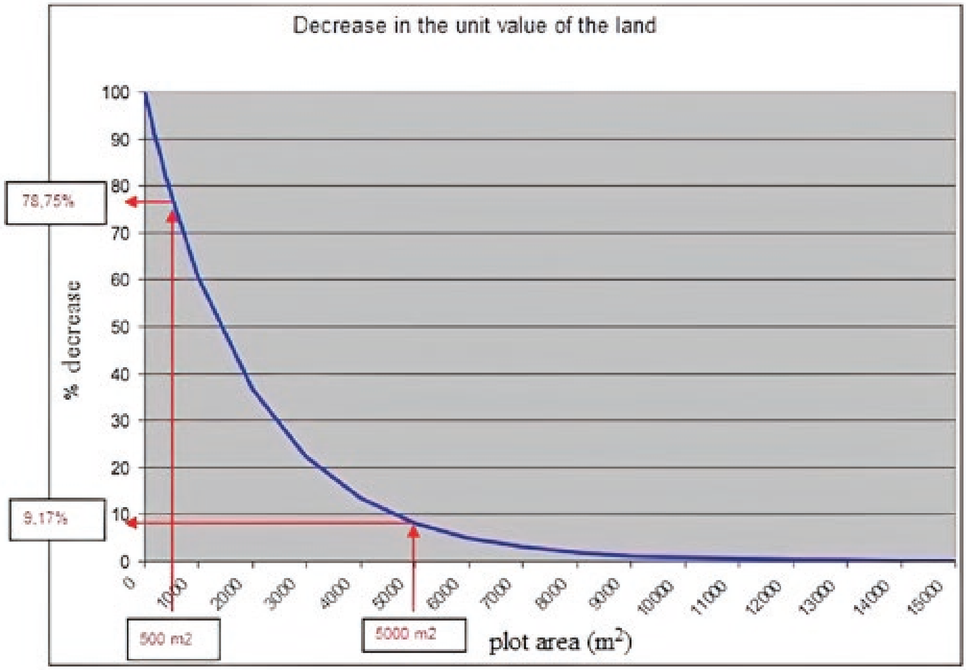
Below is a function that fits the mathematical model outlined and does not take "jumps" due to changes in land use into account. It is calculated for a real case of extensive agricultural: corn for forage and grass (2 crops, 2 years).

y = 100*118.753216(-x/10000)



Decrease in the unit value of the land (x axis: –plot area (m2) / y axis: % decrease)

Using this function, in order to determine the compensation due for a 5,000 m2 property of which 4,500 m2are expropriated, we would have to compensate 500 m2 at 69.58% (78.75-9.17) of the base unit value. If we think, for example, of a rate of 2 euros/ m2 as average for plots larger than 15,000 m2, the compensation for the rest of the property would be 695.80 euros (500 x 2 x 0.6958). This operation is reflected in the graph on the next page.



4. The updated revenue method in expropriation valuations

4.1. Problems with the use of this method

Today, the updated revenue method should be used in the vast majority of expropriation valuations (land in basic rural situations). This method is based on the principle of anticipation, according to which the value of a property can be calculated from the expected income that it will provide in the future. With this method, the better managed the land to be appraised, the greater the value obtained. For this calculation, in the case of average land use, the "value by update" should be very similar to the "market value," i.e.in the case of a less profitable crop, lower, and in the case of optimal land use, higher.

However, the truth is that for the application of this model in this realm, due to the peculiarities that it was intended to provide, there are several problems other than the size of the property that have a greater influence on the unit value obtained. The main problems are the confusion between land revenue and farm revenue, the lack of a clear interpretation of the correction factor by location, and, since 01/10/2015,[17] the change in the type of capitalization to be used (although in my opinion, fortunately, the change is not too great).[18]

The application of this method proposed by the state legislator in the LS[19] and proposed again in the current legislation[20] indirectly recognizes the existence of underutilized lands, and provides a way to avoid undervaluing land, in autonomous communities such as Galicia, where the productive capacity is generally not fulfilled. It mandates the update of real or potential income, whichever is greater, for which it is necessary to know the qualities of the soil.

Thus, at the Galician level, we are faced with another obstacle that is the lack of a map of the productive capacities of the soil on a sufficient scale and that covers the entire community. I have been convinced for a long time that such a map is a necessary instrument for any operation related to land territory, its planning, valuation, etc. How can a good municipal plan be made without it? How can land parcels be redistributed without it? How can a good valuation by updated revenue be done in large areas without it? For me the answer is clear: it cannot, or at least itis very difficult; its absence either lowers the quality of the product, or increases its cost, or both. In order to make the appropriate calculations to valuate agricultural land by updated revenue, we must consider the viable crop that will give the highest yield for the land in question and estimate its probable production. At present, in the scope of the Galician community there is only one peer-reviewed study of the productive aptitude of the land that covers the whole autonomous community. It is the "Map of the productive capacity of the soil in Galicia" by Díaz-Fierros and Gil Sotres (1984). Its scale is not adequate, but there is no alternative. In general, the information from this study is what is usually used as the basis for this type of valuation, along with other data of interest to assign the proper crop and its expected production.

17. With the entering into effect of Law 37/2015 of 29 September on roads ("B.O.E." 30 September) which amended the seventh additional provision of Law 8/2007 on land, in its wording given by RDL 2/2008 of 20 June.

18. In addition, the error due to the use of an economic update rate instead of a real estate rate was also diminished, by the greater approximation between the two.

19. RDL 2/2008, of 20 June, approving the revised text of the Land Law.

20. Revised text of the Law on Land and Urban Rehabilitation, approved by Royal Legislative Decree 7/2015 of 30 October.

4.2. The size of the property in the updated revenue method for expropriation purposes

With the current legislative framework, which refers to productive potential, when faced with an expropriation valuation that takes the small size of a property and its therefore reduced unitary value into account, the expropriated party could always argue that it would "potentially" be possible to exploit the land jointly with the neighbouring parties by grouping plots of land until an optimum surface area were obtained for this purpose. If there are no barriers between the properties, there is little to oppose this reasoning; and if there are barriers, everything could be arranged with the inclusion of a cost for their removal. This is analogous to the case of deep, flat, very fertile soil, where an agricultural crop is deemed a potentially more profitable venture than an existing forest exploitation, and so preliminary stump-cutting or other similar work is contemplated. This is why I think that in order to calculate potential income we have to act in this way, even if management costs must be charged for this joint exploitation.

5. Conclusions

The state legislator's way of thinking, as expressed in former and current land laws, which take potential income into consideration for land valuation, leads me to think that, as I explained before, he is fully aware of the existence of a great amount of underutilized land. Without directly intending to, it is the expropriated parties themselves who, seeking to increase the value of their land, find the means to alleviate the situation (by using the crops best suited to the soil, joint exploitation of land, etc.)

The above allows me to conclude that the real problem facing land management in Galicia is not the fragmentation of the land but the existence of underutilized and idle land. As long as the land remains in this state, it will remain devalued and it will not contribute as it should to the welfare of society. It is true that fragmentation often explains the idleness of the land, but it is also true that it can be fought by means other than those aimed only at defragmentation (undoubtedly the most important), such as the so-called "sustainable small farms" and the joint use of land (either using common irrigation or by leasing).

The taboo term "land reform" could be used to describe the measures necessary to improve the value of land. In my opinion, at present, the conditions for carrying out such "land reform" are better than they have been in recent years, as unemployment rates are above 15% and there has been a significant drop in the GDP, as well as a considerable demographic decline in rural areas. The depth of this reform, that is, the extent to which it can be achieved is another issue.

Enabling Technologies in Spatial Planning: from Theory to Practice

Beyond the Data in Land Planning: Municipal Land Use Planning and Surveying Local Infrastructures and Facilities

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Abstract
This chapter provides a general vision of one of the main lines of work of the Land Lab, which addresses the application of technological, methodological and conceptual innovations developed through research projects in real spatial planning and land management planning, instruments and projects. Here, we seek to showcase the essence of this field of work, which is one of the most characteristic and distinctive lines of research carried out by this group, by describing two of our most representative and long-standing projects: surveying local infrastructures and facilities and municipal land use planning. Both projects represent the group's firm commitment to strengthening ties between research and current spatial planning in Galicia.

Keywords: Spatial planning, Survey of Local Infrastructures and Facilities, urban planning, public participation.

1. Introduction

Since its origin, one of the most distinctive characteristics of the Land Lab (LaboraTe) has been the great amount of effort it has dedicated to the application of technological, methodological and conceptual innovations developed in research projects to real plans, instruments, spatial planning and land management projects. This is evidenced by the numerous studies that LaboraTe has carried out over the past two decades.

For LaboraTe, the development of Geographic Information Systems (GIS) marked the start of a process of technological innovation in the field of spatial planning and land management, which came to fruition in some of its early projects, such as the agroforestry land plan of the municipalities of Boal and Coaña and the environmental management plan for the area surrounding the Tambre hydropower plant. Starting in 2000, this activity has increased and come to include many different projects, notably including the Survey of Local Infrastructures and Facilities for the province of Lugo and the study of agricultural land planning in 17 regions of Galicia. Also worthy of mention is the work that the lab has done on comprehensive municipal land use plans, which began in 1997 with the drafting of the urban plan for O Páramo and continued with the elaboration of land use plans for Láncara, Castroverde, Guitiriz, Cervantes and Portomarín.

In the early years, the main innovations incorporated into urban planning proposals derived from the use of GIS, both for mapping and for the integration of spatial analysis (viewsheds, map overlay, etc.). Over time, the group has continued to acquire knowledge and experience in urban planning while also furthering methodological innovations for spatial planning. Thus, models and algorithms developed in research projects funded by the Galician R+D+I Plan ("Design of a methodology for rural land use planning by means of GIS and remote sensing," "Simulation of urban growth of settlements by cellular automata and GIS" and "Geographic information systems for urban and regional planning through optimization techniques on multi-core processors") and by the National R+D+I Plan ("Spatial Decision Support System for spatial planning at local level" and "Agent Based Model and GIS-web system for development, evaluation and implementation of urban and regional plans") could be applied and validated in the aforementioned comprehensive municipal land use plans. Additionally, as a result of these projects and associated doctoral theses, computer tools were developed with a practical purpose in mind. These tools, which are described in a previous chapter, include decision-making support tools for different land planning processes.

All of the projects had a marked technical character but allowed for an innovative approach, as in the case of the preliminary draft of the Strategic Plan for Rural Development in Galicia, the study of the cultural landscape of Santa Tegra and the GIS for landscape management in Cape Finisterre. By the end of the decade, the projects that had been developed were as diverse as the Municipal Emergency Plans of Lugo and Oleiros, the inventory of municipal roads in Lugo, the delineation of the historic Way of St. James from Santiago to Finisterre, the province of Lugo's water information system for the Galician sewage plan, the municipal forest fire prevention and fighting plan of Guitiriz and the prospection of the network of historical rural ways in Monte do Carrio.

This line of research also includes international collaborative projects, especially projects conducted in collaboration with Latin American countries, where the practical component and territorial planning also constituted main goals. Among these projects are the project for training in spatial planning and GIS for rural development in Loja (Ecuador), the project for institutional empowerment in spatial planning in northern Nicaragua and the study of the PDOT for zone 6 in Ecuador.

Given the impossibility of addressing all of these research-action projects in a single chapter, we have selected two of the most representative and long-standing projects from this line of work and we describe them here in greater depth: municipal land use planning and surveying local infrastructures and facilities (SLIF). LaboraTe has used two separate approaches to address urban planning: the spatial planning of rural settlement in relation to changes in legislation, and public participation in urban planning processes. Similarly, the SLIF is analyzed from three different perspectives: i) as a source of information for spatial planning, ii) in relation to the changes in the methodologies used to delineate rural settlements and iii) its usefulness for analyzing the abandonment of population settlements.

2. Municipal land use plans

Several projects developed by the Land Lab on urban and regional planning aim to provide a technical instrument for land use planning. There are examples of planning for one specific land use (forest, agriculture, etc.) or for one specific natural space, as well as examples of environmental planning and of municipal land use planning. The objective was the same in all of these plans: to achieve the correct spatial planning for the scale of intervention required.

Urban and regional planning differ conceptually in terms of their scope of action and the level of government involved, and thus their legal scope and regime are also different. Urban planning is used for municipalities (or parts of municipalities) while regional planning is used for supra-municipal areas.

This chapter attempts to explain the work done by LaboraTe in the field of urban planning based on applied research. Thus, the knowledge generated through research projects involving the development of land use simulation and planning models (Santé-Riveira et al., 2008; Santé et al., 2016) and the use of advanced GIS-based techniques and tools for data processing and the creation of online digital platforms for public participation (Díaz et al., 2008), among other studies, is applied to real projects, contributing positively to their results. In addition, a feedback process also exists, as the partnership for the development of municipal land use plans has given LaboraTe the chance to research and publish on current topics such as the modification of urban planning legislation in Galicia and the difficulties in implementing land use plans (Tubío Sánchez and Crecente Maseda, 2012).

Urban planning is a complex process which is aimed at municipal planning and is regulated by specific legislation that supports instruments with differing degrees of detail. Municipal land use plans are approved through different stages and the processing involves several sectoral bodies, which complicates the process. These complications have added to the instability of urban planning regulation in recent decades and have led to changes being made to the legislation, increasing the reluctance of municipal administrations to update their urban plans and making planners' work and administrative responsibilities more cumbersome (Crecente Maseda and Santé Riveira, 2011).

2.1. Evolution of spatial planning regulations for rural settlements

LaboraTe's partnership in municipal land use plans dates back to 1997, specifically to when the group was assigned the task of designing the urban plan (the Municipal Subsidiary Planning Rules) for O Páramo. At that time, the law concerning urban planning regulation was Act 11/1985, an adaptation of the national urban law to Galicia, known as LASGA. This was the first urban planning law in Galicia, and it adapted the national Spanish law to the specific needs of Galicia, establishing two municipal urban planning figures: the general urban plan (*Plan General de Ordenación Urbana*, PGOU) and the municipal subsidiary planning rules (*Normas Subsidiarias de Planeamiento Municipal*, NSPM). This law established a complex classification of urban land (Table 1), which already distinguished between rural settlements and urban settlements, recognizing the special characteristics of population settlements in rural environments. The law established two categories: traditional rural settlements and recent rural settlements.

Land classification	
Existing rural settlements with traditional characteristics	Land that may be partially or totally classified as urban land, either programmed or non-programmed developable land, land suitable for development or non-developable land.
Existing rural settlements recently developed	Land that may be classified as urban land, either programmed or non-programmed developable land or land suitable for development.
Existing urban settlements	Land that may include programmed or non-programmed developable land or land suitable for development.
New population settlements	Land that may include programmed or non-programmed developable land or land suitable for development.
Special protection areas	Land allocated for conservation and protection.
Protected and non-developable land	Potentially productive land.

Table 1: Land classification in PGOU and NSPM according to Act 11/1985 LASGA

In the same year, Act 1/1997 related to Galician land came into effect, which forced the urban planning instrument that was being elaborated for the municipality of O Páramo to change. This regulation included the general municipal urban plan *(Plan General de Ordenación Municipal*, PGOM) and the rural area planning project (*Proyecto de Ordenación del Medio Rural*, POMR) as urban planning instruments, the latter being the best-suited to the characteristics of the municipality of O Páramo. In addition to this change in the urban planning figures, Act 1/1997 introduced a new land classification scheme (Table 2), which established a clearer differentiation between urban land and rural settlements.

When Act 9/2002 on urban planning and rural environment protection of Galicia (LOUGA) was passed, the concept of a rural area planning project officially disappeared, which led to major changes in the spatial planning proposal that was being developed for the municipality of O Páramo. Under this new legal framework, the only official urban planning figure for planning the whole extension of the municipality was the general municipal urban plan (*Plan General de Ordenación Municipal*, PGOM), which came into effect at that moment (Figure 1). In this case, the new law also implied changes to land classification (Table 3), including the differentiation of two categories of rural settlement land: traditional and expansion area. Table 4 summarizes the spatial planning proposal for O Páramo's PGOM, including the areas of different land classes and categories, established according to the criteria of Act 9/2002.

Figure	**Land class**	**Land category**
PGOM	Urban	Consolidated
		Unconsolidated
	Developable land	-
	Rural settlement	-
	Rural land: common and special protection	Common
		Special protection
POMR	Urban land	Consolidated
		Unconsolidated
	Rural settlement	-
	Rural land	-

Table 2: Land classification in PGOM and POMR according to Act 1/1997

Land class	**Land category**
Urban land	Consolidated
	Unconsolidated
Developable land	Delineated
	Non-delineated
Rural settlement land	Traditional rural settlement
	Expansion area
Rural land	Common protection rural land
	Special protection rural agricultural land
	Special protection rural forest land
	Special protection rural infrastructure land
	Special protection rural land for water
	Special protection rural costal land
	Special protection rural natural space land
	Special protection rural landscape land
	Special protection rural cultural heritage land

Table 3: Land planning classes and categories according to Act 9/2002

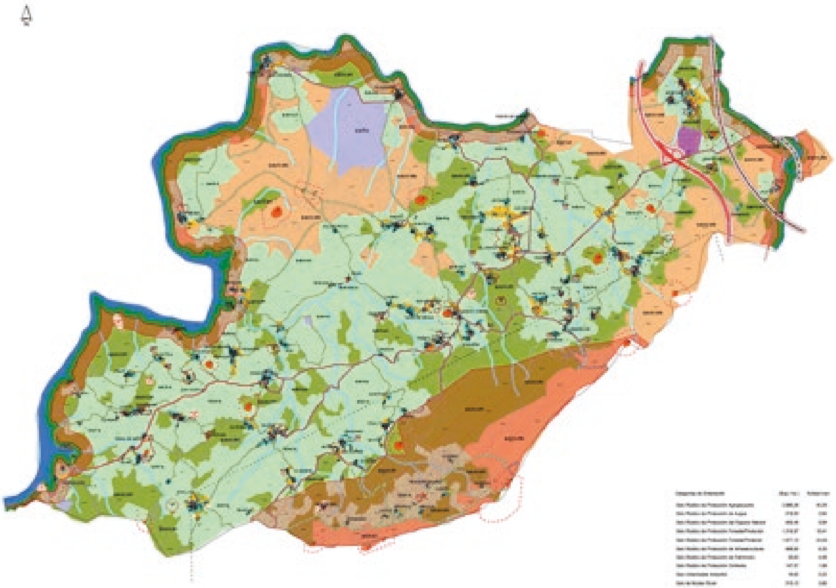


Figure 1: Land use map of the municipality of O Páramo according to the criteria of Act 9/2002

In 2009, after several years of processing the PGOM, the final step of the process was reached: the documentation of the PGOM was submitted for provisional approval by the municipal plenary, before evaluation and final approval by the regional government. However, the municipal corporation decided to detain the process and close the file.

Act 9/2002 was subject to successive amendments, the last and most-involved of which was Act 2/2010, a modification of Act 9/2002, on urban planning and rural area protection in Galicia. This amendment involved a reformulation of the legal concept of rural settlement with the aim of addressing the different typologies of rural population settlements (Table 5). The concept of rural settlement evolved from a conception based on urban growth, to the current concept related to historical heritage. Where formerly, the category of "expansion area" in Act 9/2002 was defined according to distance from traditional buildings, under the new Act 2/2010, the traditional-built area is used to distinguish the historical-traditional area from the common area (Barbosa-Brandao et al., 2015) by delineating both areas on the basis of their building density. After this law amendment, plans that were being processed but had not yet reached the provisional approval stage (the stage prior to final approval) had to be adapted to the new legal framework.

Land class	Area (ha)	Area (%)	Land category	Area (ha)	Area (%)
Urban land	0.00	0.00	Consolidated	0.00	0.00
			Unconsolidated	0.00	0.00
Developable land	16.62	0.22	Delineated	0.00	0.00
			Non-delineated (industrial)	16.62	0.22
Rural settlement land	209.01	2.90	Traditional rural settlement	132.23	1.78
			Expansion area	76.78	1.13
Rural land	7,184.49	96.88	Common protection rural land	147.57	1.99
			Special protection rural agricultural land	2,985.26	40.25
			Special protection rural land for forest production	1,216.97	16.41
			Special protection rural forest land	1,671.12	22.53
			Special protection rural infrastructure land	469.50	6.33
			Special protection rural land for water	218.00	2.94
			Special protection rural costal land	0.00	0.00
			Special protection rural natural space land	440.44	5.94
			Special protection rural landscape land	0.00	0.00
			Special protection rural cultural heritage land	35.63	0.48
Total	7,410.12	100.00		7,410.12	100.00

Table 4: Areas of land planning classes and categories of O Páramo's PGOM at the provisional approval stage (2009)

Land class	Land category
Rural settlement land	Historical-traditional rural settlement
	Common rural settlement
	Complex rural settlement

Table 5: Rural settlement classes according to Act 2/2010

In 2016 the current Act 2/2016 on land in Galicia was passed. One of the main challenges of this new law is the acceleration of the processing of urban planning.

To this end, the law regulates two different municipal urban planning figures depending on urban complexity: the municipal general urban plan (PGOM) and the municipal basic plan (*Plan Básico Municipal*, PBM), the latter of which has shortened the administrative processes. The law also introduces the figure of a regional basic plan (*Plan Básico Autonómico,* PBA), which serves as a starting point for basic municipal plans.

On the other hand, sectoral reports processed by different administrative bodies are now centralized in the regional urban planning department. This is intended to ensure compliance, specifically to ensure that report deadlines are met, something which, despite being legally regulated, in practice was not always guaranteed and often excessively delayed the processing. Another relevant aspect of the law, which streamlines urban planning processing, is the incorporation of the strategic environmental assessment process into the processing of urban plans, where previously the two processes were independent and parallel.

Land class	**Land category**
Urban land	Consolidated
	Unconsolidated
Developable land	Delineated
Rural settlement land	Traditional rural settlement
	Common rural settlement
Rural land	Common protection rural land
	Special protection rural agricultural land
	Special protection rural forest land
	Special protection rural infrastructure land
	Special protection rural land for water
	Special protection rural costal land
	Special protection rural natural space land
	Special protection rural landscape land
	Special protection rural cultural heritage land

Table 6: Land planning classes and categories for the figure PGOM according to Act 2/2016

Land classification remains similar to that under the previous law (Tables 6 and 7), although some nuances, such as the removal of non-delineated developable land and the introduction of complex rural settlement land, thus subtracting a typology, do not improve the recognition or identification of population settlements. Regarding rural land, the rural land classes and categories of both common and special protection land are maintained, although the latter are now defined exclusively on the basis of the protection and conditions established under sectoral legislation.

Act 2/2016 allowed the municipality of O Páramo to take advantage of a new urban planning regimen that is simpler in both technical and processing aspects and, therefore, better adapted to the resources and the urban and territorial characteristics of the municipality. Currently, the municipality of O Páramo is processing its basic municipal plan (PBM), an urban planning instrument for municipalities with fewer than 5,000 inhabitants, low urban complexity and thus no PGOM. LaboraTe has had the opportunity to collaborate with the regional urban planning department on this PBM.

Land class	**Land category**
Urban land	Consolidated
Rural settlement land	Traditional rural settlement
	Common rural settlement
Rural land	Common protection rural land
	Special protection rural agricultural land
	Special protection rural forest land
	Special protection rural infrastructure land
	Special protection rural land for water
	Special protection rural costal land
	Special protection rural natural space land
	Special protection rural landscape land
	Special protection rural cultural heritage land

Table 7: Land planning classes and categories for PBMs according to Act 2/2016

In the case of O Páramo, the change from a PGOM, regulated by Act 9/2002, to a PBM, as introduced in Act 2/2016, also brought changes to the land classification, including the disappearance of the non-delineated developable land, a category not included in the new law. Added to this is the notable decrease in the area occupied by rural settlement land; a reduction of 28.33% in the case of traditional rural settlements and a reduction to almost half of the previous area (reduction of 42.43%) in the case of common rural settlements.

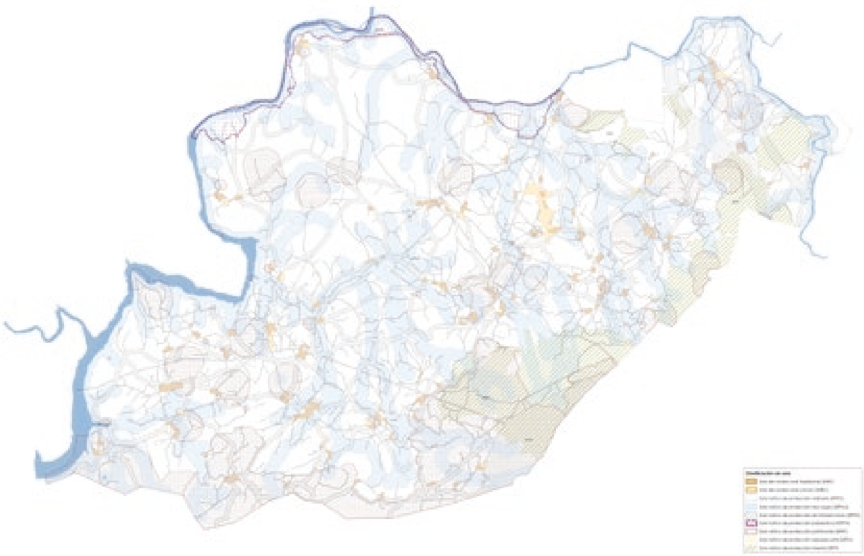


Figure 2: Land use map of the municipality of O Páramo according to the criteria of Act 2/2016

With regard to rural land categories, the main differences involve the categories of special protection rural agricultural and forest land, due to the different criteria used in the spatial planning of these categories established by each law. While Act 9/2002 defined protected agricultural land as land with high agricultural or livestock productivity and protected forest land as land intended for logging and land with tree stands to be protected, Act 2/2016 limited these areas to include only land areas defined by official instruments as well as consolidation projects in the case of protected agricultural land and common land in the case of protected forest land. The result is that rural land planning is left in the hands of the sectoral governing bodies that have authority in rural areas. In O Páramo, the lack of sectoral instruments led to a decrease in special protection rural agricultural land from 40% of the municipal area in the PGOM to virtually nothing (0.03%) in the PBM.

The area of special protection rural infrastructure and cultural heritage land and special protection rural land for water increased by 128%, 165% and 1.054% respectively, as a result of regulatory changes and improvements to the available geographic and land information. The appearance of special protection rural landscape land came about in 2016 with the Landscape Inventory of Galicia, which zoned special interest landscape areas (Santé et al., 2018).

Land class	**Area (ha)**	**Area (%)**	**Land category**	**Area (ha)**	**Area (%)**
Urban land	0.00	0.00	Consolidated	0.00	0.00
			Unconsolidated	0.00	0.00
Developable land	0.00	0.00	Delineated	0,00	0,00
Rural settlement land	138.97	1.70	Traditional	94.77	1.16
			Common	44.20	0.54
Rural land	8,052.48	98.30	Common protection rural land	3,462.23	42.27
			Special protection rural agricultural land	2.80	0.03
			Special protection rural forest land	731,89	8,93
			Special protection rural infrastructure land	1,071.21	13.08
			Special protection rural land for water	2,514.85	30.70
			Special protection rural landscape land	175.14	2.14
			Special protection rural cultural heritage land	94.36	1.25
Total				8,191.43	100.00

Table 8: Areas of land classes and categories of the PBM of O Páramo at the initial approval stage (2020)

In 2001, LaboraTe began collaborating on the PGOM of Láncara under Act 1/1997. As in the case of the municipality of O Páramo, the implementation of Act 9/2002 meant adapting the PGOM, but in this case the plan completed processing and the final approval was given in 2013. The final approval of the PGOM of Castroverde under Act 9/2002 was also given in 2008, although the process was initiated in 2003.

Currently, LaboraTe is collaborating on the development of the PGOMs for the municipalities of Guitiriz, Cervantes and Portomarín. The processing of the PGOM for Guitiriz began in 2004 reaching the advanced, pre-report and initial approval by public participation stages, but the provisional approval was not given before Act 2/2010 came into effect, so that a complete review of the rural settlement spatial planning proposal was necessary to account for the new categories of rural settlements and the new criteria for their delineation.

As an example of the implications of the changes in criteria for the delineation of rural settlement land introduced by Act 2/2010, Figure 3 represents the area of two rural settlements in Guitiriz according to the criteria established by each law. In this case, Act 2/2010 established the physical separation of the two settlements, leaving several vacant parcels outside the area of the settlement, and extending the area of one settlement by two parcels. Both modifications are a consequence of the aforementioned shift from the expansion area based on distance from traditional buildings (which allowed for the inclusion of vacant parcels), to a definition of rural settlement based on building density.

Figure 4 shows an even greater decrease in the area of the rural settlement as a result of the implementation of Act 2/2010. As in the previous case, the exclusion of vacant parcels in two adjacent areas led to their separation into two distinct delineated areas. In fact, in this case, some of the most external parcels, both vacant and occupied by building structures, are not included in the area of the rural settlement.

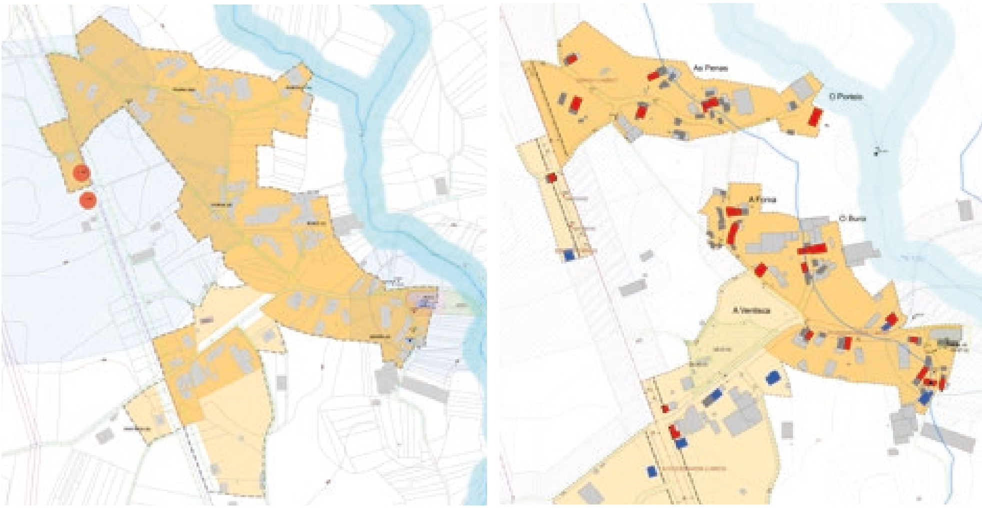


Figure 3: Delineation of the rural settlements in As Penas/Portelo and O Buriz/A Forxa/A Graña/a Ventisca (parish of Buriz, San Pedro) according to Act 9/2002 and Act 2/2010, at the initial approval (2009) and final approval (2020) stages of the PGOM for Guitiriz,[1] respectively

1. The traditional rural settlement and historical-traditional rural settlement land is depicted in dark ochre, while the expansion area and common rural settlement are depicted in light ochre.

Figure 4: Delineation of the rural settlement land in As Pardiñas (parish of Lagostelle, San Xoán) according to Act 9/2002 and Act 2/2010, at the initial approval (2009) and final approval (2020) stages of the PGOM of Guitiriz1, respectively

In addition to the modifications of the criteria for rural settlement planning, adapting the Guitiriz PGOM to meet Act 2/2010 also involved other changes. These changes, which include a 16% decrease in the urban land area, a 7% decrease in developable land area and a 13% decrease in the area of rural settlement land (Tables 9 and 10), indicate a trend towards greater control of urban growth and, consequently, greater sustainability and environmental protection, which is in line with European Union guidelines (European Commission, 2012).

On the other hand, changes in the land and, more fundamentally, in sectoral laws meant an increase of 559 ha in the area of protected natural spaces, of 1,070 ha in the special protection rural cultural heritage land and of 942 ha in the special protection rural infrastructure land.

Land class	**Land category**	**Area (ha)**		**Area (%)**
Urban land	Consolidated	114.09	131.24	0.44%
	Unconsolidated	17.15		

Land class	**Land category**	**Area (ha)**		**Area (%)**
Developable land	Delineated	50.74	50.74	0.17%
Rural settlement	Traditional rural settlement	485.83	593.27	1.98%
	Expansion area	107.44		
Rural land	Special protection for agriculture	14,304.31	29,141.33	97.41%
	Special protection for forest	6,901.17		
	Special protection for natural spaces	1,634.68		
	Special protection for water	3,406.37		
	Special protection for cultural heritage	47.81		
	Special protection for infrastructure	2,691.42		
	Common protection	155.57		
Total			**29,916.58**[2]	**100.00%**

Table 9: Areas of land classes and categories of the PGOM for Guitiriz at the initial approval stage (2009)

Land class	**Land category**	**Area (ha)**		**Area (%)**
Urban land	Consolidated	91.15	109.77	0.35%
	Unconsolidated	18.63		
Developable land	Delineated	47.00	47.00	0.15%
Rural settlement	Traditional rural settlement	193.61	517.26	1.67%
	Common rural settlement	31.30		
	Complex rural settlement	292.34		

2. The total area is not equal to the area of the municipality of Guitiriz because the different categories of rural land can be overlaid in order to apply the different land use regulations in a complementary way. The different categories are not mutually exclusive.

Land class	**Land category**	**Area (ha)**		**Area (%)**
Rural land	Special protection for agriculture	14,272.74	30,268.01	97.82%
	Special protection for forest	6,813.43		
	Special protection for natural spaces	2,193.42		
	Special protection for water	1,541.54		
	Special protection for cultural heritage	1,118.22		
	Special protection for Infrastructure	3,633.41		
	Common protection	330.30		
	Special protection for Agriculture/forest	229.18		
	Landscape protection	135.76		
Total			**30,942.05**	**100.00%**

Table 10: Areas of land classes and categories of the PGOM for Guitiriz at the final approval stage (2020)

2.2. The application of GIS in urban planning

At each stage of the spatial planning process some tasks can be systematized and optimized, such as data collection and processing, elaboration of thematic maps for subsequent analysis, determination of the optimal land use for each parcel, zoning of land classes and categories and drafting of documentation, among others. Improving the efficiency of these tasks, which are aimed at obtaining new information, also increases accuracy and precision and ensures quality decision-making. For example, in order to delineate rural settlement land, it is essential to have a as accurate a representation of the population settlement as possible.

Compiling existing information and collecting new data are highly demanding tasks from a resource point of view. The fieldwork for the development of a PGOM essentially includes collecting data on buildings, roads, utilities, cultural heritage elements and any other characteristics that are needed to model the population settlement. Wherever and whenever possible, alphanumeric data collected in the field should be incorporated into a previously designed GIS (Figure 5). The information collected is reviewed through office work, aided by photographs taken in the field, in order to correct any incidents.

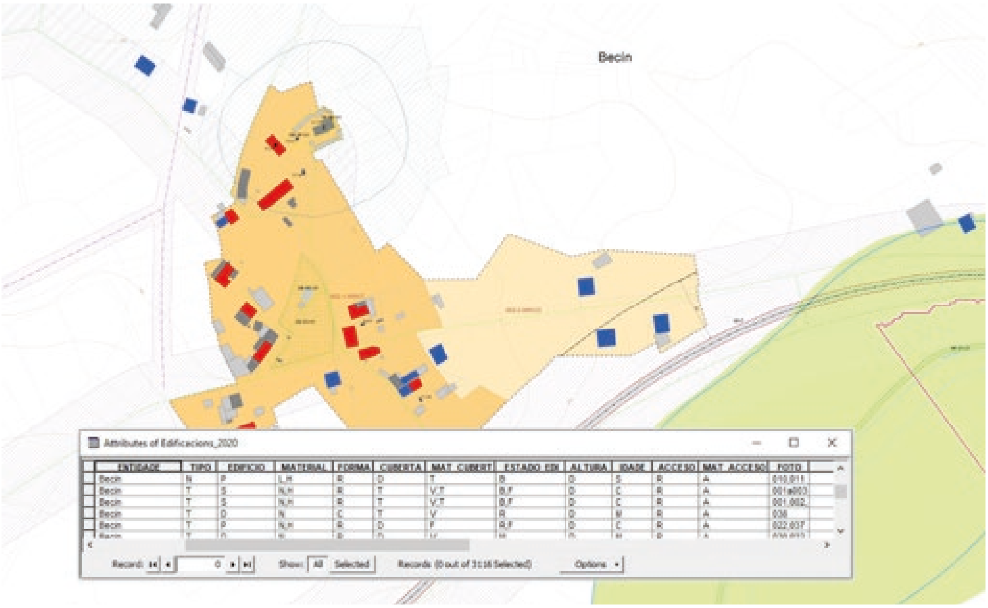


Figure 5: Example of attributes from the GIS buildings layer

Taking photographs in the field while collecting information is essential for later data validation, and even in the subsequent phases of the planning process the photographs are often consulted to aid in elaborating new information and solving different incidents that may arise (Figure 6).

Data collected in the field constitute an important part of the input information for this kind of project. Other types of basic cartographic information include data generated by official agencies or data that are increasingly available through web platforms. In Galicia, these data are available through the Spatial Data Infrastructure of Galicia (www.mapas.xunta.gal), where the official regional cartography (the Topographic Database of Galicia) as well as other sources of geographic information, including aerial orthophotographs, Lidar data, digital terrain models, land use maps, and geological maps, can be downloaded and consulted.

Figure 6: Examples of photographs taken in the field

For a given study area, input data are processed using GIS software and by applying spatial analysis techniques to produce a series of maps that provide detailed information about the land, such as elevation, aspect, slope and land use (Figure 7). In addition, by simply analysing the spatial component of certain elements, such as road infrastructure or utilities, relevant information, such as the proportion of the population that is served by public services and supplies, can be obtained.

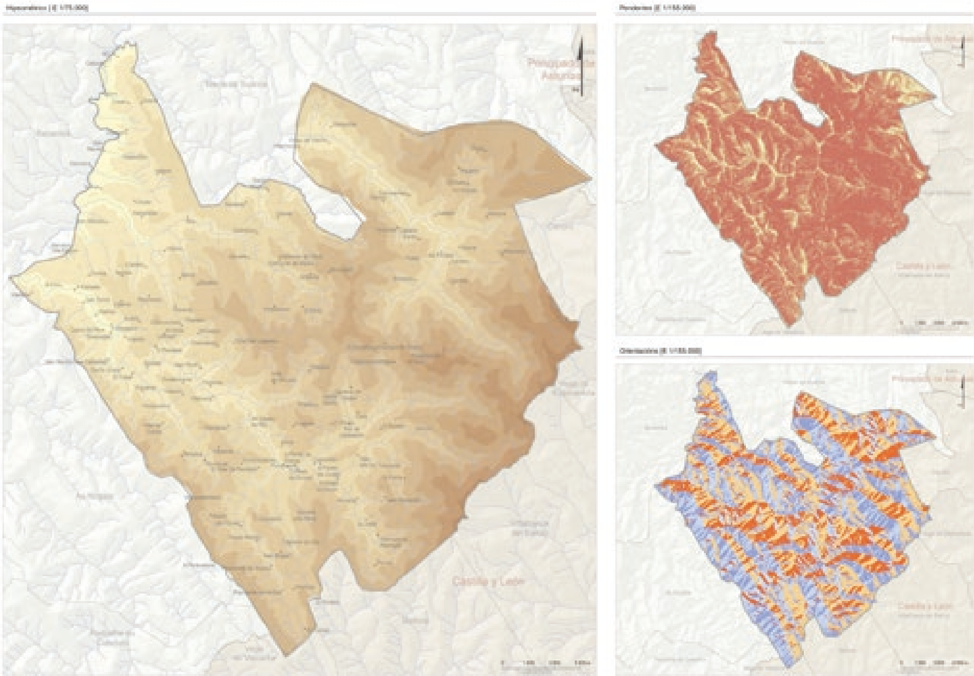
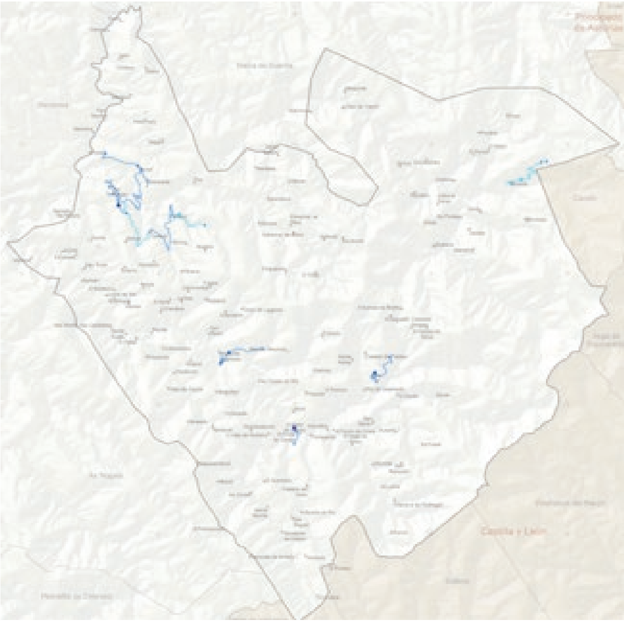


Figure 7: Thematic maps depicting the elevation, slope and aspect of the municipality of Cervantes (Lugo)

Generating thematic maps using GIS tools allows depiction of the study area which is faithful to reality, and therefore allows for a more objective diagnosis, which is the starting point for land use planning (Figure 8).



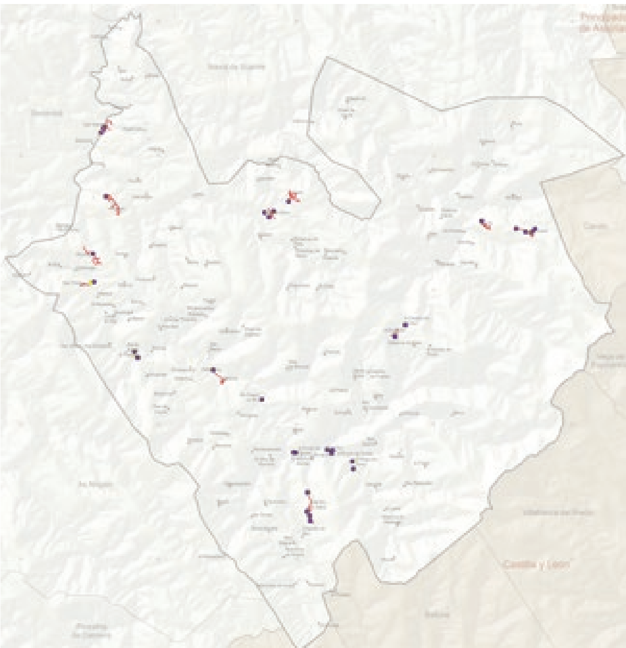


Figure 8: Thematic maps of the water supply and sewerage networks in the municipality of Cervantes (Lugo)

2.3. Public participation in urban planning

Processing a municipal land use plan includes two stages in which the general public has the opportunity to participate; this has been true since the repealed Act 9/2002 and applies to the current Act 2/2016.

Land use plans are subjected, either in a simplified or ordinary form, to a strategic environmental assessment, which includes a period of public exhibition. At this point, agencies, institutions and anyone who is interested can submit suggestions, provide information and identify errors, all of which must be taken into account in the planning process. The other public participation process occurs once the initial approval has been given, when the spatial planning proposal is publicly presented and new reports are requested from the corresponding sectoral governing bodies; these reports now become binding, and a favourable report from each governing body is therefore required before the processing of the plan can be continued.

In the field of urban and regional planning, LaboraTe does research on and applies new public participation procedures in municipal land use plans. The idea is that people affected by the plan understand its scope and become involved in its development in order to raise awareness about the different potential weaknesses as well as possible opportunities.

Even in LaboraTe's first municipal land use plans, like the PGOM of O Páramo, which began in 2003, surveys and neighbourhood meetings were held during the preliminary stages, to collect suggestions and information about any problems detected. This process was repeated in the development of subsequent plans for the municipalities of Guitiriz, Cervantes and Portomarín.

During the public exhibition following the initial approval, the law dictates that the plan's documentation must be available to the public in the city council's offices for two months and that this must be announced in the press. In the case of the Guitiriz PGOM, the exhibition and dissemination of the plan was further reinforced through several neighbourhood meetings, which included individualized advice given in person by the technical team and by the delivery of digital copies of the plan so that people could analyze the documentation in detail before submitting any objections.

Simultaneously, the complete documentation of the plan was made publicly available on the Guitiriz PGOM Information System (SIGui) web site, which is described in another chapter of this book. This tool offered access to the plan at any time and without restrictions, expanding the possibility for public participation as well as the transparency of the whole process. By means of this web site, citizens could consult the plans, documentation and maps both as a digital document and interactively through a map web server, as well as raise objections to the plan directly through an online form.

3. Survey of Local Infrastructures and Facilities (SLIF)

The Survey of Local Infrastructures and Facilities (SLIF) instrument enables quantitative and qualitative analysis of municipal public services. The SLIF is a national, census-level inventory aimed at obtaining up-to-date knowledge of the situation and supply level of local infrastructures and facilities in municipalities with populations of less than 50,000. This survey was developed according to a standard methodology established by the Ministry of Land Policy and Public Function (MLPPF), the governing body which is also responsible for monitoring the survey, making certain that it is updated and carrying out any necessary maintenance.

This survey originated in 1985 and until the 2005 edition, it had a five-year periodicity, before becoming annual, in 2008. In the case of the province of Lugo, the provincial Government of Lugo is responsibe for development of the SLIF. LaboraTe has collaborated in the project since the 2000 edition, specifically aiding in the implementation and updating of the 66 surveyed municipalities (the entire province of Lugo except the municipality of Lugo).

From the start, LaboraTe supported this work with the development of a GIS that was specifically designed for managing the project, which represented a major advancement on previous editions (Varela et al., 2003).

Another of the novelties introduced was making the information available through the Web, providing public access to all information on the survey since 2008, at the web address https://eieldelugo.usc.es/es/about.html. On this same webpage, information from the different SLIF editions since 1995 can also be accessed. The information is supplied through an online query viewer (from 2011) by means of WMS, WFS and CSW download services (from 2011) as well as overview documents downloadable in PDF format (from 2008). Currently, all the functionalities of this website are compatible with free open-source software. In addition to the aforementioned functionalities, the web also has a tool for the visual comparison of layers, which allows the user to see the data collected in the different editions of the SLIF and also a catalogue of the names of settlements in the province of Lugo.

Data presented by MLPPF in 2009 in Madrid at the FEMP Training Day *"The Spatial Model as Data Support in the Survey of Local Infrastructures* *and Facilities (SLIF)"* showed that at the national level, the infrastructures and facilities had been digitalized for only half of the settlements included in the SLIF. Only eight of the provincial SLIFs, one of which was Lugo's, ensured easy and user-friendly access for querying or downloading spatial data related to the SLIF (Varela et al., 2010).

Although a priori this project may seem to have only a small research component, LaboraTe approached it from the perspective of the potential interest and applicability of the SLIF for spatial planning and land management, focusing on three different approaches:

— The SLIF as a source of information for spatial planning and land management.
— The methodological changes in spatial planning for rural settlements.
— The utility of the SLIF for analysing the abandonment of population settlements.

Before addressing these three approaches, it is necessary to clarify the meaning of entity and population settlement in the SLIF and in other sources (the National Institute of Statistics-NIS, urban planning and others):

— *Singular entities*, according to the NIS are those settlements registered in the NIS catalogue. They constitute the framework for identifying surveyed settlements.
— *Singular entities of population* are the settlements from the NIS catalogue that are included in the SLIF because they meet the requirements.
— *Populations* or *population settlements* are the singular entities surveyed in the SLIF and those that are not surveyed but included because they have one or more important facilities. They are not synonymous with *singular entities* because several singular entities can be grouped into the same population settlement.
— *Rural settlement land* is defined in section 1 of this chapter.

3.1. The SLIF as an information source for spatial planning

From the outset, the SLIF for the province of Lugo included more than 3,750 population settlements that were registered in the NIS catalogue. Beginning with the 2016 edition, the number of settlements analysed has increased. The survey was intended to be finished by the 2019 edition, in which more than 5,000 population settlements would be surveyed.

The SLIF compiles an immense amount of data on a wide range of topics (Varela et al., 2010), including infrastructures. There are several types of infrastructures, according to the tree classification proposed by Gil et al. (1998). According to this classification, the information included in the SLIF related to anthropogenic infrastructures can be divided into two groups depending on whether or not the infrastructure is linked to a settlement.

The information linked to settlements collected in the SLIF is described in Table 11. Among the information not linked to settlements is the "roads" layer, which includes the ownership (national, regional, provincial or municipal), state, roadbed and width of each stretch of road.

Information layer	Description	Attributes
Lighting	Georeferenced light points	Power and type of connection
Streets	Public roads that give access to houses and facilities and are located inside the established settlement	State, roadbed and width for each stretch. Number of houses with unpaved road access
Roads	National, regional, provincial and municipal roads that provide access to buildings or facilities	Ownership, state, roadbed and width for each stretch
Sewage network	Information on all elements of the network	For each element in the network, estate data, ownership and management are collected
Water treatment plants	Purifier systems	Capacity, type of treatment, deficiencies, destination of sludge
Sewer pipes	General wastewater pipes	Material and water circulation system
Sewage outlet pipe	Pipe stretching from the treatment plant to the dumping point	Material, diameter and length of the outlet pipe, type of zone of dumping and treatment suitability
Sewage networks	Networks that collect waste and storm water from buildings	Type of water, material, transport system, diameter
Water supply network	Information on all elements of the network	For each element in the network, estate data, ownership and management are collected
Watersheds	Location of watersheds	Watersheds, protection, counter and use

Information layer	**Description**	**Attributes**
Water tanks	Tanks for water storing	Capacity, protection, counter and cleaning year
Water purifiers	Water purification systems	Types of treatments, type of installation and location
Main water pipes	Main drinking water pipes	Material
Water pipes	Network for supplying houses	Material and transport system
Facilities	Facilities	For each facility, estate data, area, access, ownership and management are collected
Public buildings not in use	Publicly owned buildings without a current use	Previous use
Landfills	Landfills and recycling plants	Type of service, capacity, degree of occupation, service lifetime, identified problems
Funeral houses	Funeral houses	Rooms
Town halls and other municipal buildings	Administrative buildings with municipal ownership and other uses	Type, owner
Cemeteries		Occupation, extension possibility, church and crematorium
Care centres	Senior day care centres and residences, nursery schools	Type, number of users
Cultural centres	Buildings dedicated to cultural and recreation activities	Type of centre, activities carried out
Emergency centres	Civil protection and fire fighting	Type of centre, number of professionals, available material
Education centres	Buildings where official classes are taught	Official centre code, field, type of education
Health centres	Health services	Type, number of beds, ICU
Collective buildings	Police quarters, prisons and convents	
Hotels and hostels for pilgrims		Number of beds

Information layer	Description	Attributes
Sports facilities	Installations for sports practice	Type, sports
Slaughterhouses		Capacity, lines for processing
Markets and fair-grounds		Type of area, services (electricity, water, sewage, coffee shops, playgrounds, others)
Parks, gardens and natural areas	Facilities for outdoor leisure	Type of area, services (electricity, water, sewage, coffee shops, playgrounds, others)
Family houses	Houses according to cadastral data	Type of house (principal, secondary), number of homes per building

Table 11: Information linked to settlements in the SLIF

In spatial planning, both anthropogenic and natural (derived from the environment) infrastructures are strategic elements in the analysis of land development and cohesion. Thus, the availability of maps that represent these elements throughout the territory facilitates land planning and development (Vázquez, 2016), especially if appropriate techniques, such as those offered by GIS, are used. The management of and equitable access to resources are fundamental issues and the cause of much debate not only for local and regional governments, but also for the European Union (Nieto et al., 2017). Several studies use the spatial distribution of facilities and infrastructures to analyse the quality of life in a given area (Moreno, 2007) and the differences between more- and less-developed areas (Harvey, 1977). The SLIF layers enable analysis of the spatial distribution of the different facilities within a territory and provide a good estimation of the facilities that are managed by local administrations. Because of this, these layers are extremely important for spatial planning and for the preliminary land diagnosis of study areas. For this reason, the SLIF is a valuable decision-making tool for processes such as spatial planning, resource allocation, interregional cooperation and for other related issues at all levels of jurisdiction (national, state, provincial and municipal).

3.2. Methodological changes in spatial planning for rural settlements

The information included in the SLIF must be collected at the population settlement level, as indicated in the SLIF Instruction Manual. With the aim of establishing an unambiguous criterion for the identification of population settlements, the survey manual defines a potentially-surveyable population settlement as a settlement that meets any of the following criteria: being identified in the current urban plan; being defined by the corresponding regional body; or falling under the NIS definition, which refers to any "group of at least ten buildings forming streets, squares and other urban ways." According to the NIS criterion, the number of houses that constitute a settlement may be less than 10 if its populations is greater than 50 inhabitants. By exclusion, the houses in a singular entity that cannot be included in the concept of settlement according to the NIS criterion are considered "dispersed."

The SLIF must include all of the population settlements in a municipality that meet these criteria, as well as those that, despite not meeting the survey criteria, meet the specific criteria established by each Province or Island. Information on all infrastructures and facilities must be collected for each population settlement that at the time of the survey is considered a "surveyed population settlement."

The first surveys carried out in the Province of Lugo raised several points related to the aforementioned issues. First, the need to establish a criterion to identify which settlements to survey out of the many singular entities that exist in the province, and secondly, the need to define a methodology to unambiguously locate and delineate settlements in order to allow for the subsequent allocation of facilities to each settlement.

Regarding the first issue, the survey considers a "singular entity" to be any habitable area of a municipality, inhabited or (as an exception) uninhabited, that is clearly differentiated and known by a specific name that unmistakably identifies it. An area is considered habitable when it has houses that are inhabited or in condition to be inhabited according the 2011 SLIF Instruction Manual.

In the case of Galicia, there are a large number of singular entities according to the aforementioned criterion, due to the sprawl of the Galician urban habitat, a phenomenon that has its roots in ancient times but continues to the present day (Lamparte et al., 2010). In a large part of the territory the population settlement system is not composed of compact settlements but rather of houses that are dispersed throughout the territory, generally concentrated in agricultural areas, usually the most fertile ones, and thus form more- or less-dispersed settlements without clearly identifiable boundaries. These population settlements are generally referred to as "places", "villages" or "neighbourhoods", and are grouped into collective entities called "parishes", which are more encompassing than settlements but less encompassing than municipalities. The mountainous areas and the southeast of Galicia are the exception to this general rule, where settlements are generally more compact and defined, and frequently each settlement, or group of several well-defined settlements, forms a parish.

From the beginning of the survey, we opted to include entities based on the strict definition of "population settlement" from the Survey Instruction Manual, i.e. sets of at least ten buildings forming streets, squares and other urban ways. The only exception to this was the grouping in certain areas of singular entities, which individually did not meet the inclusion criteria, into larger entities, where it was warranted by the housing density, the difficulty for planning or the current social reality. Entities registered in the NIS catalogue were taken as a starting point for identifying the singular entities to be surveyed, as recommended in the survey manual. For example, of the 9450 singular entities registered by the NIS and grouped into 2723 surveyed population settlements, 3721 singular entities were surveyed in the 2009 edition (Table 12).

Edition	Singular entities according to NIS	Singular entities surveyed	% entities surveyed	Population settlements surveyed
2009	9450	3721	39.38	2723
2010	9451	3721	39.37	2723
2011	9455	3721	39.35	2723
2012	9456	3721	39.35	2723
2013	9461	3721	39.33	2723
2014	9464	3721	39.32	2723
2015	9467	3721	34.55	2723
2016	9493	4116	43.36	3206
2017	9494	4738	49.91	4098

Table 12: Changes in singular entities and population settlements surveyed in the SLIF between 2009 and 2017

Regarding the second issue, as previously mentioned, in most of the Galician territory there are no clear boundaries between different population settlements. Moreover, the location of many singular entities is doubtful, i.e. the exact location of these settlements is unknown. In order to solve this issue geographically, i.e. to delineate the boundaries of the surveyed settlements, we decided to calculate the convex hull of the houses that are considered to belong to a single settlement. Initially, the sources of information used for the location and delineation of settlements were, on the one hand, the fieldwork based on the delineations carried out by the local residents, and on the other hand, the municipal censuses. The latter include the Municipal Census and the NIS register, which is usually based on the Municipal Census. Obtaining information in this way can be problematic because there are often discrepancies between neighbours, who do not agree on the definition of the boundaries between settlements, and because the delineation provided by the local residents often differs from that adopted by official governing bodies. Municipal censuses usually have different mechanisms for collecting information on settlements and often do not have an objective criterion for defining settlements, so the neighbours themselves, in collaboration with the person responsible for the census, usually define the settlement of their houses. In municipalities with a major urban settlement, it is common for the surveyor to have detailed knowledge only of the settlements located in the immediate surroundings of the main settlement, allowing the local residents themselves to define both the settlements where their houses are located and the definition of new settlements if they have been recently developed.

One indication of the disparity between different inclusion criteria, and also of the urban sprawl in Galicia, is given by the increase in the number of population entities registered by the NIS between 2009 and 2017. This increase, very great but constant, reflects the registration of inhabitants in singular entities not previously considered as such, but which are incorporated into the system through municipal censuses.

In addition, using these methods to procure information was extremely demanding in terms of both human resources and time, because the municipal census systems were initially only rarely computerized and because fieldwork and meetings with neighbours were necessary to delineate settlements.

From the first editions to the 2015 edition, the survey included approximately 40% of the existing population settlements in the province, representing roughly 60% of the total population of the province (Table 13). However, due to the sprawl of the population, a large number of infrastructures and facilities were registered imprecisely as “dispersed” , which was too short a definition and did not include georeferenced information. In addition, the spatial distribution of the population throughout the territory, and therefore the available facilities, were not precisely addressed within the original scope of the survey (Mora-García and Marti-Ciriquian, 2015).

Edition	Surveyed population*	Population of Province of Lugo	%
2009	193,814	355,549	54.51
2010	193,267	355,195	54.41
2011	209,432	353,504	59.24
2012	207,843	351,530	59.13
2013	205,878	348,902	59.01
2014	203,480	346,005	58.81
2015	201,236	342,748	58.71
2016	203,490	339,386	59.96
2017	210,593	336,527	62.58

*The population registered by the NIS for the previous year that was included in each survey edition.

Table 13: Population surveyed in each edition from 2009 to 2017

Due to the aforementioned problems, starting with the 2016 edition and for the following three editions up to 2019, the Provincial Government of Lugo decided to expand the survey, including population settlements with between 5 and 10 houses. This extension (as shown in Table 14) aimed to increase the scope of the survey to include 60% of the existing population entities in the Province (excluding the municipality of Lugo) and 66% of the total population of the Province, which amounts to 93.9% of the population when the municipality of Lugo is excluded. Lugo was excluded because the SLIF is intended exclusively to collect information on municipalities with fewer than 50,000 inhabitants. Expansion of the survey enabled many of the infrastructures that were not previously digitized to be included in the survey and registered in detail. Additionally, the expansion provides, through an annual report, a compendium of data that is required to calculate the effective costs of the services provided by local administrations. In this way, the information collected by the survey increases the precision and accuracy of these estimates, which must be carried out annually by local administrations, and contributes to the transparency and monitoring of public funds (Carrasco and Buendía, 2014).

The increase in the number of surveyed entities has, once again, raised the problem of the delineation of new settlements. A new procedure has been put into practice for this purpose.

First, as done at the beginning of the survey, the entities to be incorporated were identified from the last official housing census in Spain, which dates back to 2011. Although rather outdated, this is the only information available for the moment. The housing data were filtered to identify the singular entities with between five and nine houses.

Edition	Surveyed entities	% of the entities of the Province of Lugo (excluding the municipality of Lugo)	Surveyed population	%of population of the Province	% of provincial population excluding the municipality of Lugo
2016	4,116	43.36	203,490	59.96	84.35
2017	4,738	49.91	210,593	62.58	88.39
2018 *	5,195	54.72	214,609	64.32	91.08
2019 *	5,657**	59.58	219,094**	66.12	93.91

** currently 2018 and 2019 editions have not been officially approved*
*** Data estimated from data from the 2017 survey*

Table 14: Extension of the survey

The existing houses in the province were then identified from cadastral data, which were processed in order to extract the buildings classified as houses (Mora-Garcían and Marti-Ciriquian, 2015). As the survey data are stored in geospatial databases, this procedure was carried out by means of automatic filtering through SQL queries and through spatial operations with GIS.

A data review was then required because the cadastral data do not enable the geometries classified as houses to be fully distinguished from the remaining buildings. This mainly occurs in rural areas, where the same cadastral reference may correspond to several buildings of different types, so that a relationship between the building and its use cannot be established unambiguously. In addition, the number of dwellings in a given building cannot be obtained directly from the public cadastral data. This mainly applies to urban areas, where multiple geometries usually define each building. It is therefore necessary to carry out several calculations in order to, first, geometrically define a building and, second, assign a number of dwellings to that geometry.

Once the geometries of the houses have been determined, the third step is to identify which houses comprise a single settlement. For this purpose, information is collected from municipal censuses, interviews with municipal technicians and geographical data from municipal real estate taxes. In the case of municipal real estate taxes, the cadastral reference is linked to the physical address of the house, which generally includes the settlement name. This step allows rural settlements to be roughly located and delineated efficiently while employing the economic use of resources, for a subsequent more precise approximation using other aforementioned data sources.

3.3. The use of the SLIF for analyzing settlement abandonment

The SLIF data model includes a list of the existing abandoned settlements in each municipality, to provide a vision of their possible recovery. This is increasingly important in Spain, due to the widespread phenomena of settlement abandonment, resulting from a process of loss of inhabitants that began many decades ago. Currently, in the Iberian Peninsula, entire provinces show large population loss, with an increasing number of settlements suffering abandonment and/or deterioration. This phenomenon has been called "empty" or "emptied Spain." Although the most pronounced changes are mainly being observed in the provinces in the centre of the peninsula, the populations have been decreasing in Galicia, the Province of Lugo, along with the Province of Ourense during the last several decades. Meanwhile, they have also undergone a process of population concentration in several settlements, so that other areas have been abandoned. In the case of Lugo, the capital city is the settlement with the most pronounced growth in the province, and some of the other larger remaining settlements have also been able to grow or, in some cases, merely maintain their population in recent years, whereas the mountainous areas of the province have lost the most population.

Regarding the applicability of the SLIF to study this process, the main problem is that the concept of abandonment is not explicitly defined in the survey manual, so there is no clear criterion that establishes which entities should be included in the register of abandoned settlements.

A priori, the most-easily-adoptable criterion for the identification of abandonment may be depopulation, i.e. a settlement can be considered abandoned when it has no inhabitants registered in the official census. Table 15 shows the number of population entities in the Province of Lugo without census dwellers or with a single census dweller, the latter being candidates for depopulation in subsequent years, although they can already be considered depopulated. The sum of these population entities constitutes 13.45% of the settlements in the province, 1,277 in total, according to the 2018 edition of the SLIF. These settlements comprise a total of 1,869 houses according to the 2011 housing census, from the total 134,662 houses registered in the Province, excluding those that lie within the municipality of Lugo.

For the province of Lugo, a density map was calculated from the centroids of the population settlements with 0 or 1 inhabitants. This map allows the areas with a high incidence of depopulated settlements or at risk of depopulation in coming years to be identified. These areas seem to be concentrated, on the one hand, in the northern mountains, between O Xistral and the Eo River, especially in the West, between the region of Viveiro and the municipality of Muras, and on the other hand, in the South and Southwest of the province, in the regions of

A Ulloa, Chantada, Sarria and Lemos, becoming more prominent closer to the Ribeira Sacra.

As shown in the map in Figure 9, the areas with a greater incidence of settlements without inhabitants do not always correspond to those areas considered the most depressed from a demographic point of view nor with those with the highest population decline in recent decades. This may be due to a combination of several factors, including the type of settlement, whether dispersed or concentrated, and local-scale population movement dynamics, which in turn depend on other factors such as accessibility of the settlement.

Finally, as far as the SLIF is concerned, that population entities that could have been included in the register of abandoned settlements, according to the aforementioned population criterion, show good habitability conditions, sometimes constituting surveyed settlements in the SLIF. Many of these settlements have infrastructures and/or facilities which have even been recently renovated or extended and which are in operation and registered in the survey. Therefore, a criterion based on population would not appear to be the most suitable for defining abandonment, as many settlements without inhabitants, or with few inhabitants, registered in the census are occupied intermittently, usually on weekends or during summer periods, with a high degree of occupancy relative to the census population. In most cases, these inhabitants not registered in the census justify the provision of facilities or infrastructures to meet the high demand that occurs during periods of occupation, thus the condition of these settlements is usually far from what would be expected of an abandoned settlement.

Edition	Singular entities in the Province of Lugo	Singular entities with 0 inhabitants	%	Singular entities with 1 inhabitant	%
2012	9456	603	6.38	405	4.28
2013	9461	621	6.56	430	4.54
2014	9464	645	6.82	456	4.82
2015	9467	684	7.23	447	4.72
2016	9493	719	7.57	464	4.89
2017	9494	743	7.83	494	5.2
2018	9494	770	8.11	507	5.34

* Population data from each survey edition correspond to the NIS register from the previous year.

Table 15: Changes in singular entities with 0 or 1 inhabitants according to survey data

One method that would enable these settlements to be classified more accurately would be to classify the existing houses in the settlement, which would be obtained from a new national housing census. The census could identify whether the houses are first residences, second residences or abandoned and/or uninhabitable houses. To date and until a more precise criterion can be applied, the settlements identified as abandoned are those that are registered with 0 inhabitants in the current and previous edition of the survey. This data is cross-referenced with the information from the local council in order to elaborate a definitive and more accurate list of truly abandoned settlements.

Figure 9: Density map of settlements in the Province of Lugo with 0 or 1 inhabitants, excluding the municipality of Lugo. Data source: the 2018 SLIF

4. Conclusions

This chapter highlights the benefits of and the need for the integration of research and action (real plans and projects) in the field of land planning and management. Two types of projects—urban plans and the SLIF—serve as examples of how technological and methodological innovations can improve efficiency and outcomes, while at the same time showcasing how experience in authentic land management helps identify problems that need to be solved in this field of research.

Over the last two decades, LaboraTe's partnership in the development of municipal urban plans has provided an experimental framework for working with different urban laws, observing first-hand the difficulty in their application and generating new knowledge with the aim of improving spatial planning.

LaboraTe is currently reformulating and adapting the methodology used to draft urban land planning instruments in order to meet the specifications of the new urban law passed in 2016, a law which stands for simplicity in processing and implementation. This will allow for further analysis and research on the effectiveness of land use planning and its contribution to global land management.

Moreover, the current health situation caused by Covid-19 pandemic has led to reconsideration of the relationship between citizens and the administration. It is now recommended that all types of administrative procedures be carried out online. In the case of public participation in the implementation of a land management instrument, this situation could represent an opportunity for further research on the development of web tools to obtain citizens' opinions without their presence being required at any stage of the spatial planning process.

For the entire Province of Lugo, the SLIF faces the challenges of increasing accuracy and the percentage of the population it covers. In a territory with urban sprawl this would allow local administrations to use the survey for more efficient location of infrastructures and facilities and also to improve the management of public municipal services, by generating analyses such as optimal routes.

In this respect, the collaboration among different local administrations and their departments also presents challenges in relation to executing the survey and converting it into a collaborative spatial data infrastructure. To this end, all administrations involved could contribute by updating the survey in real time, more accurately and consistently, by incorporating data about changes in infrastructures and facilities, number of inhabitants, and existing houses, as well as other information. By integrating all activities with spatial components in any given municipality, this spatial data infrastructure has the potential to be a comprehensive management system for census management and urban planning at a local level. This system could more efficiently and accurately analyze data, making the management of facilities and infrastructures easier.

The SLIF also has the potential to establish synergies with other fields of research. For example, relationships between SLIF data and data on facilities, especially those related to sewage, water supply and recreational uses and the assessment of ecosystem services, could be established. These overlapping areas present interesting new opportunities for research and analysis that should be explored.

Acknowledgements

For Rafa (in memoriam), from whose biography we have taken the following excerpt:

> "que me facía"feliz",... e lembrei que dende pequeno os vraos na casa de meus avós... todo era escapar para alí!; voltar tirado boca arriba no cumio dun carro cargado de herba verde recén cortada, tirado polo cabalo, era o máis próximo á felicidade; ben pouco era!".
> "it made me "happy,"… and I remember summers at my grandparents' house when I was little,… it was my getaway place!; returning home lying on my back on top of a horse drawn cart heaped with freshly-cut grass was the closest thing to happiness; and it sure wasn't much!."

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Web-based PPGIS for Public Evaluation of Land Use Planning: Application to the Land Use Plan of Guitiriz, NW Spain

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Abstract
The development of comprehensive land use plans is a long and arduous process that requires great effort from local governments and technical teams. The new web-based geographic information system (GIS) technologies can help to facilitate land-use planning processes and promote public participation. In this study, a web-based Public Participation GIS (PPGIS) was developed to encourage public participation and provide citizens with a tool that enables them to prepare and submit comments or objections and to receive relevant responses. The proposed tool is also useful for technicians, insofar as it allows for easier and faster processing of and response to comments and objections. The PPGIS is cost-effective, multiplatform tool that can be easily adapted and extended as it is based on widely used free software, architecture design patterns and developmental frameworks. The system was applied to the public evaluation of the draft land use plan of Guitiriz, a municipality in NW Spain. The study findings demonstrate the utility and capacity of the tool to facilitate land-use planning processes, especially

for citizens residing outside the municipality.

Keywords: GIS-web, land planning, public participation, plan evaluation.

1. Introduction

The process of developing and approving comprehensive land use plans can be a long and arduous task that requires great effort from local governments and technical teams. The effort is even greater in rural municipalities with small populations, lack of resources and limited numbers of technical and administrative staff. Hence there is an increasing demand for tools that support land-use planning processes. Geographic information systems (GIS) have traditionally been used in daily operations by governments and public administrations (Caldeweyher et al., 2006). However, the lack of resources and/or expert staff who know how to use these technologies hampers implementation of GIS in many small municipalities, i.e. where the systems are potentially of most benefit.

Spatial planning processes must consider the preferences of multiple stakeholders, who are demanding an increasingly active role in the processes. Public participation is necessary to help technical teams identify the most sensitive planning issues and improve the results of land use plans. Through public participation processes, planners gain access to local knowledge, which is a vital complement to scientific knowledge (Ball, 2002). However, the lack of appropriate tools is an obstacle to the effective implementation of public participation (Golobic and Marusic, 2007). Such obstacles can be overcome by integrating GIS in public participatory tools, which is achieved by using Public Participation GIS (PPGIS) (Craig et al., 2002; Poplin, 2012a; Sieber, 2006).

Web technology has proved very useful for providing public access to information and research data that were previously only available to technicians and for counteracting the traditional criticism directed against GIS for being elitist tools that increase the gap between technicians and public administration and the general public (Sikder and Gangopadhyay, 2002). At present the internet meets the criteria of an interactive medium required for public participation (Ball, 2002) and enables two-way communication between citizens and urban planners (Mansourian et al., 2011).

Web-based GIS solutions provide an inexpensive, efficient way of delivering map products to users (Tripathy, 2002). When applied to spatial planning, web-based GIS open up the land use regulation process –formerly limited to professionals– to citizens and provide an effective medium for public participation (Yaakup et al., 2001) insofar as users can access GIS data and maps with no requirements for technical skills and no need to own GIS software programs. Web-based solutions enable citizens to access information on land use plans and to obtain updated information on the progress of the plans, there by increasing community involvement in the decision-making process. GIS are no longer only used by planners, and they are increasingly being used by community organizations for planning (Elwood, 2002).

Many web-based GIS allow users to view and query information related to urban planning. Thus, the web-based GIS Urban Management Information System (UMIS; Ozturan et al., 2004), which integrates digital base maps and statistical data for cities, provides a variety of querying and reporting options; the web-based GIS developed by Hossack et al. (2004) provides authorities with information, data and guidance on the sustainable management of urban land; the CAD/GIS/BIM open web services were integrated for urban data management and evaluated by Lapierre and Cote (2008); and the Web GIS described by Anrong et al. (2006) is used to share information for general urban planning in Beijing. Some of these applications include tools that are used in urban planning management. For instance, Culshaw et al. (2006) designed a web-based GIS to support decision-making within the UK planning framework that supported three planning functions: pre-planning enquiries, development control decisions and strategic planning. Another example is the web-GIS based urban planning and information system proposed by Tripathy (2002), which was used by authorized technicians in the municipal corporation to produce a visual display of all day-to-day queries, maps and maintenance reports.

The first web-based PPGIS aimed at encouraging public participation and increasing the involvement of citizens in spatial planning processes enabled users to view and query geographic and alphanumeric data only (e.g.Yaakup et al., 2001). One step further in the development of such systems enabled a two-way flow of spatially referenced information. One of the first and best-known systems of this kind was the system described by Kingston et al. (2000) and Carver et al. (2001), in which citizens can view maps and attach suggestions to specific locations in the planning area, in order to improve their village, and in which all users can view existing comments. Rinner (2001) introduced argumentation maps as a way of supporting map-related discussions in on-line planning, and Bugs et al. (2010) proposed a similar PPGIS that enabled users to enter their opinions by selecting an icon whose colour identified a planning topic and then placing the icon on the map and labelling their comments as suggestions, questions, complaints and positive or negative comments. Along similar lines, Han and Peng (2003) designed a PPGIS for managing common properties in a public housing estate that enabled citizens to report problems and make suggestions regarding a precise location on a map but aimed at housing-estate management, whereas Poplin (2012b) described the integration of interactive GIS maps and an online questionnaire. Recent PPGIS include tools that enable more complex spatial analysis and multicriteria decision-making techniques. These systems are relatively common within the framework of environmental planning, e.g. Rao et al. (2007) described a web-based GIS that integrated a hydrological model and an image classification tool for planning the USDA's Conservation Reserve Program, while Sikder and Gangopadhyay (2002) integrated a hydrological model and a web-based GIS for visualizing changes in the distribution of pollutants after a change in land use, and Ghaemi et al. (2009) implemented an Interactive Park Analysis Tool to calculate the potential use of parks when a user allocates a new plot to a park by using geoprocessing operations. However, very few PPGIS for urban and regional planning include multicriteria decision-making techniques. For instance, Dragicevic and Balram (2004) developed a web-based GIS framework that integrated two sets of tools from the ArcIMS software: MapNotes and EditNotes. These tools enabled participants to enter georeferenced comments and sketch polygons on a digital map to indicate proposed regions in order to configure the GIS Collaborative Spatial Delphi method for the Web. McHugh et al. (2009) proposed a PPGIS based on SOLAP technology that enabled users to make more complex spatial queries and calculate measures on-the-fly according to weights given by citizens to the different characteristics. The web-based GIS proposed by Simao et al. (2009) was more complete and included an argumentation map and a simple multicriteria evaluation module in which citizens could assign weights to evaluation factors and visualize the consequences of the decision-making process to classify alternative sites for wind farms.

Even more complex multicriteria decision-making techniques were integrated in the PPGIS described by Mansourian et al. (2011), which enables users to submit applications for development permits. Through spatial analysis operations, the GIS engine compares the submitted application and the existing plan and, if the application conforms to the plan, the permit is granted. In addition, the application is subject to the opinion of citizens, who can assess the application on the basis of suitability maps that they themselves construct using an analytical hierarchical process (AHP) and combined with concordance analysis into a final suitability map used by local authorities to reach the final decision. The

Ecosystem Portfolio Model (Labiosa et al., 2013) is another example of PPGIS for land-use planning that incorporates multicriteria evaluation techniques to assess land-use plans by using a set of environmental and economic indicators.

However, we have not found any examples of web-based PPGIS that allow users to file georeferenced comments or objections during the development of land use plans, or examples of similar applications that have been formally evaluated by implementation during the public review of real land use plans.

According to the Spanish urban planning law, one of the main ways that the public can participate in municipal planning is by submitting comments or objections at different stages of the planning process. The system presented here aims to respond to the need for automation in the processes required to prepare, process, submit and respond to any comment or objection. In order to file an objection, citizens must have access to a great deal of information. However, this information is usually stored in paper format in the town council and as citizens cannot take the documents to their homes, this limits the time they have available to review the relevant details. The comments or objections filed by citizens are therefore often unfinished or do not reflect the real situation. The easiest and cheapest way for both technicians and citizens to obtain such information is via the internet. Web-based GIS provide information in a visual, interactive way and enable users to overlay the selected information layers. Accordingly, an application based on web and GIS technologies has been developed to encourage public participation, to bring information closer to citizens and to provide citizens with a tool that enables them to prepare and submit comments or objections and to receive relevant responses. The developed tool aims to be useful to citizens, but also to technicians, insofar as it enables easier and faster processing of and response to the comments and objections filed by citizens.

In the following section, we describe the design of the application, the technologies and tools used to build it, its potential users and the main functionalities of the system. Following the description of the design, we discuss a real example of implementation of the application in a municipality in Galicia (NW Spain) and we present the conclusions drawn from this evaluation for a potential future extension of the application to other municipalities in the region.

2. Web-Based PPGIS

The application consists of two large modules that respond to the two main general requirements of the system: querying geographic and alphanumeric data associated with the land use plan and processing comments or objections. The first module consists of a GIS-web that provides access to geographic data and is totally independent of the second module. The second module consists of a web application that manages the processes required to file and respond to comments or objections, and includes a map viewer that enables users to visualize and obtain the geographic information needed to prepare an objection report.

2.1. System architecture

The programming language used was Java for the J2EE platform (Java 2 Platform, Enterprise Edition), which provides a modular, portable and scalable design (Caldeweyher et al., 2006). The following software development frameworks were used:

- Struts, which provides a total separation between the appearance and the functionality of the application through the design pattern known as MVC (Model View Controller) and therefore offers easier maintenance and extension capacities.
- Spring, which manages all the transactional processes between the application and the databases, both the geographic database and the comment and objection database. In addition, Spring provides security support and user control through its security module, known as Acegi.
- Hibernate, which allows users to perform object-relational mapping between the tables in the database and the objects of the Java classes implemented in the application.

Data were stored in two geographic databases. The first database comprised all of the geographic data layers that were collected or generated for the land use plan, while the second database was used to store information related to comments or objections, the citizens who filed them, the answers to the comments or objections, and also the geometry of the plots of land involved. Both databases were implemented with DBMS PostgreSQL and the spatial extension PostGIS. Because the system does not support raster data, the GDAL library (with X/MIT license) was used to write and read raster maps.

All of these data and tools must be provided through servers. In this case, we used two different servers. One of the servers, Tomcat, was used to support the application, whereas the other, Apache, was used to provide the geographic data. MapServer was used as a web map server because it supports OGC standards (Open GIS Consortium - http://www.opengeospatial.org/) and all major GIS formats, and it works directly with PostGIS and GDAL.

The geographic viewer was developed using the DBOX library, which can make requests directly to a MapServer server. Requests to the map server are made through AJAX, creating the URLs by JavaScript and submitting them with XMLHttpRequest requests.

The architecture described here guarantees total independence of the platform in which the system is implemented. To make integration and scaling of the application easier, we used a three-tier architecture, which splits the technical architecture into three layers: the visualization layer, the business logic layer and the control layer. With this scheme, we avoided modifying the three layers each time a change was made in one layer.

2.2. Functionalities

Four types of application users were defined: visitors, citizens, technicians and administrators. Visitors comprise users who access the web but who are not registered in the application. These users can only query information. Citizens are registered users, who are therefore allowed to file comments or objections. Technicians review and respond to the comments or objections filed by citizens and make the information generated in each stage of the plan available, whereas administrators are responsible for managing the application. The actions that can be carried out by the different users are summarized in Figure 1. As can be seen in the figure, bottom level users have access to the functionalities of upper level users, so that administrators have access to the functionalities aimed at technicians, who in turn have access to the functionalities aimed at citizens, who can also access those foreseen for visitors'.

Visitors can register in the system by entering their personal data. Once registered, visitors can carry out all the actions allowed to citizens. To file a comment or objection about the state of a plot, citizens must geographically locate the plot or plots that cover the area affected by the comment or objection with the help of the geographic viewer, which displays the municipal orthophoto, the cadastral map and the map of land use categories, among other layers (Fig. 2). In addition, plots of land can be located by entering their cadastral reference. Following plot location, the application provides the user with a form that can be filled in with the comments or objections regarding the selected plot. Users can attach a maximum of three files with additional data (Fig. 3), which may include the maps of the selected area generated with the geographic viewer. After data entry is completed, citizens can check the file generated with the comment or objection report for online submission to local government technicians. Once the file has been submitted, citizens can verify the state of their comments or objections at any time.

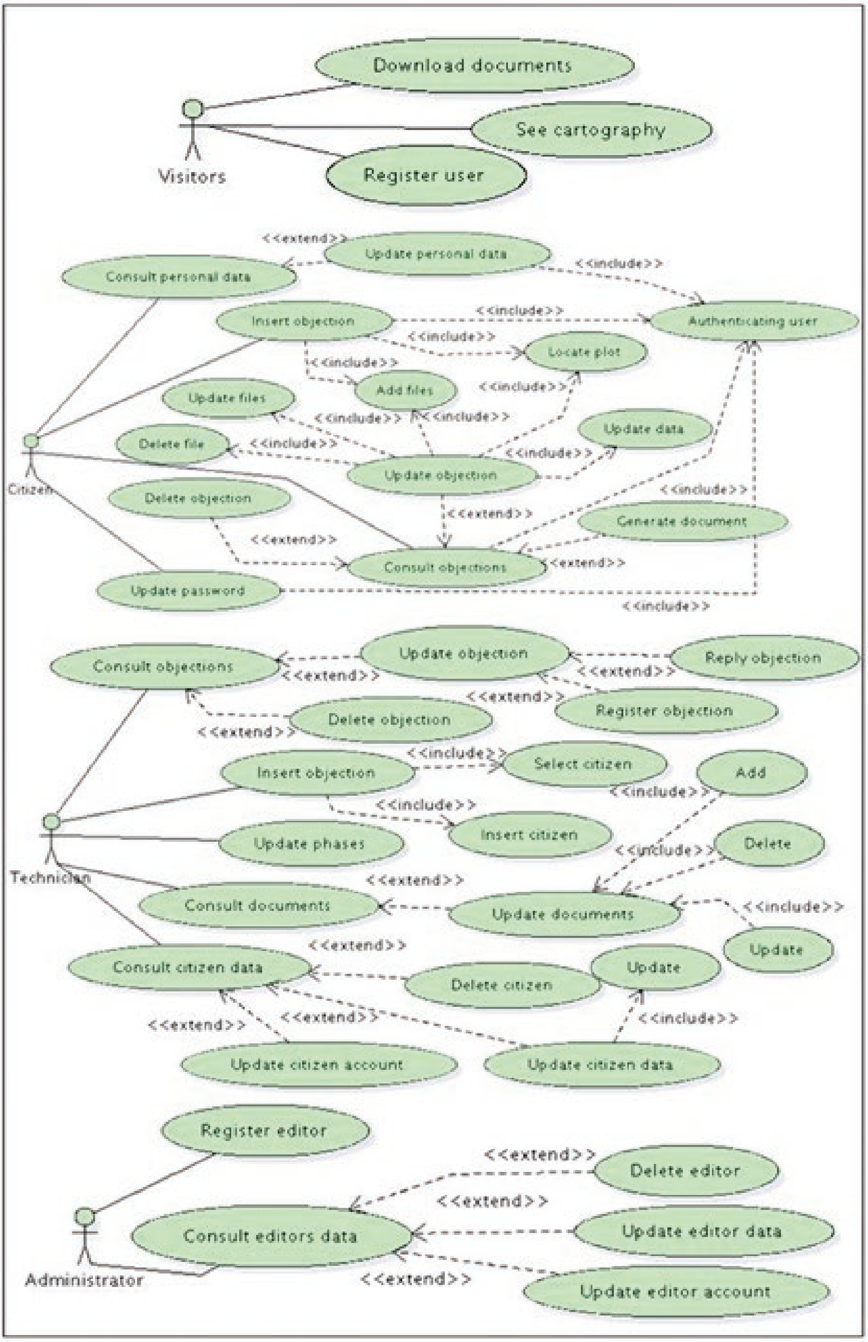

Figure 1: Actions available to different users

Figure 2: Geographic viewer

One function of technicians is to review and respond to the comments or objections submitted by citizens. However, because the ability to file a comment or objection is not restricted to internet users only, technicians must sometimes register citizens who have filed a comment or objection in paper format and enter their comments or objections in the web application. In addition, technicians are responsible for making the documents generated at each stage of the plan accessible through the website. Finally, the main function of administrators is to manage technical staff, although they have access to all the functionalities of the other types of users.

In short, the functionalities of the application can be divided into three classes: public, internal management and geographic viewer functionalities. Public functionalities comprise all of the actions allowed to citizens:

— Querying geographic and alphanumeric data included in the land use plan. Locating plots in the map viewer by entering the cadastral reference and retrieving the alphanumeric attributes.
— Registering as a user.

— Querying and modifying user's personal data.
— Making comments or objections and attaching additional information. Additional documentation can include maps generated with the geographic viewer.
— Checking the state of a comment or objection.
— Checking the current development stage of the land use plan.

Internal management functionalities include those functionalities that are only accessible to technicians and administrators:

— Entry of data from citizens, technicians and administrators.
— Querying citizen data.
— Collection of comments or objections and associated documentation.
— Entry, modification or submission of responses to comments or objections (Fig. 4).
— Determining the current development stage of the land use plan and of the length of each stage.
— Managing the alphanumeric documents available for download a teach stage.

The geographic viewer functionalities are available to both public and internal users and comprise the spatial location of the area selected for comment, retrieval of data about the plots affected and their zoning regulation according to the land use plan, measurement of distances, querying graphical and text documentation of the plan, and visualization of general geographic and alphanumeric data of the municipality. All of these functionalities are added to the typical functions of a GIS for map visualization and browsing, such as zoom operations, spatial queries and retrieval of attribute information. General municipal data include data stored in local geographic databases, such as administrative divisions, road networks, hydrography, topography, land use data, buildings or urban services and data from WMS services of different regional and national organizations, including orthophotos and cadastral maps. The use of WMS and WFS standards and advanced Spatial Data Infrastructures enables extension of the number of data layers available in the viewer. Users can turn map layers 'on' or 'off' according to their needs. This data can be used by citizens to justify their claims when filing an objection. For example, by measuring the distance between a plot and the road network, the closest river or a cultural heritage element, users can verify whether the protection assigned to a plot by the plan is acceptable. The functionalities of the system aim to satisfy the principles of e-governance, in which informed decisions usually require specialist information (Culshaw et al., 2006). Citizens can also check whether the information used in the plan development faithfully represents the actual situation, and they can help technicians to identify errors and validate the information used in the land use plan.

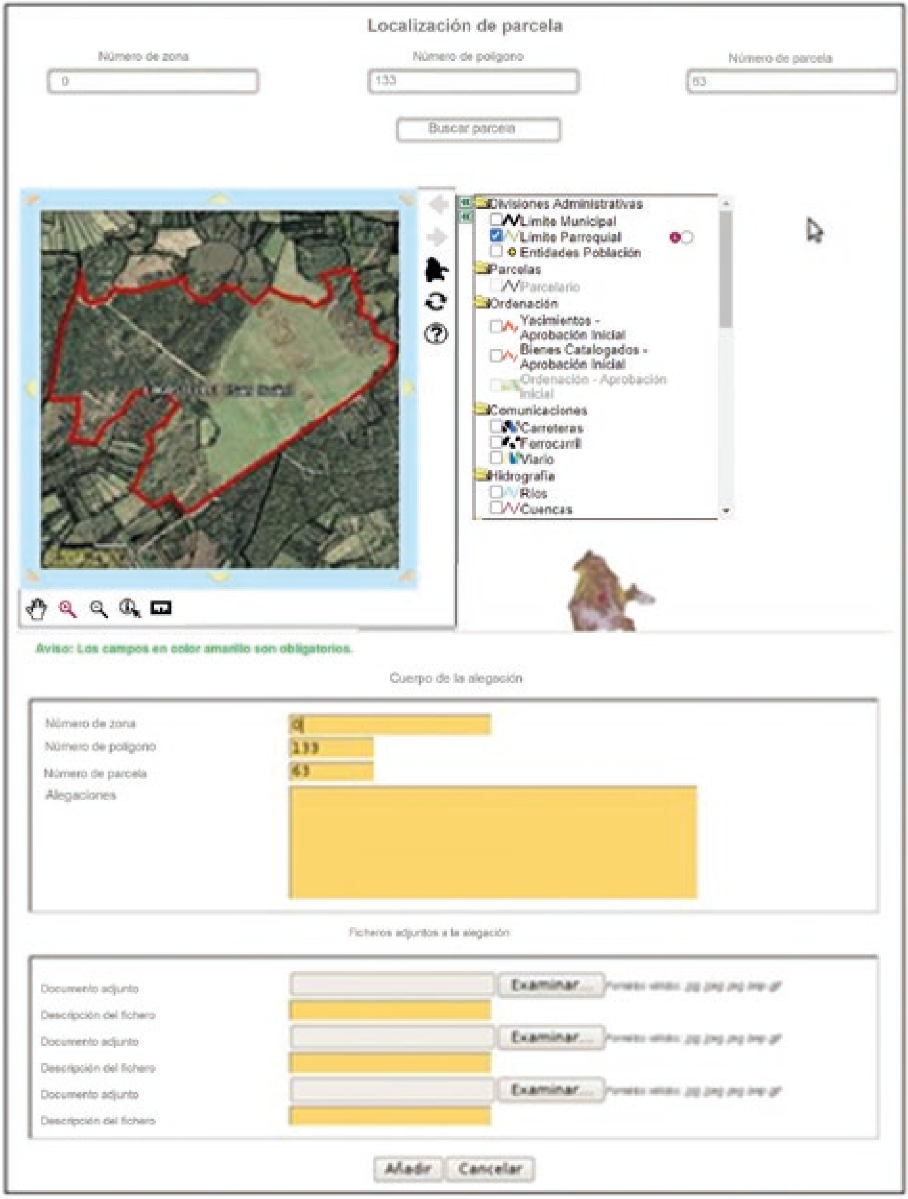

Figure 3: Geographic viewer and web form for comment submission

Figure 4: Web form for responding to comments or objections

3. Application to the comprehensive land use plan of Guitiriz

Galicia is one of the 17 autonomous regions in Spain. Autonomous regions have the legal competence to regulate land use and urban planning. In 2002, the Galician government passed an act (Act 9/2002 related to local planning and protection of rural areas of Galicia) that required all the municipalities in the region to develop a comprehensive land use plan before 2006, according to the regulations established in the act. However, to date only 55 of 315 municipalities have approved the required plan. In this light, creating tools that facilitate local government efforts to develop comprehensive land use plans and speed up the administrative process is essential. The system presented in this paper has been applied to the case of Guitiriz, a rural municipality with a small technical and administrative team. Our aim was to evaluate the functionalities of the tool and assess whether its use could be extended to all the Galician municipalities that are currently developing comprehensive land use plans (153 of 315 municipalities).

Pursuant to Act 9/2002, the administrative process for the development and approval of a comprehensive land use plan consists of various stages: advance, draft plan approval, provisional approval and definitive approval. During the advance stage, the strategy, guidelines and general objectives of the plan are outlined. The advance document must be exhibited to the public for at least one month, during which citizens can make proposals or suggestions. However, at this stage, there is no legal requirement for the authorities to respond to these suggestions. During the draft plan approval stage, the draft plan approved by the Galician government is made available for public review for a minimum of one month and a maximum of two months. During this period, comments or objections to the plan can be filed by citizens or associations. The comments or objections filed at this stage must be addressed individually by technicians. Finally, the provisional and definitive approval stages are completed by the local and regional governments. Essentially, Act 9/2002 provides for public participation at two stages of the plan development process: at the advance stage, through proposals or suggestions, and at the draft plan approval stage, through the submission of comments or objections. In the description of the application, reference was made to comments or objections only, but the system can also be used for managing proposals or suggestions at the advance stage.

To file a comment or objection, citizens must fill in a form to which additional clarifying documents can be attached. Once the review period is over, the local government submits the filed comments and objections to the planning team, which prepares a technical report on these comments/objections. Based on this report, local government technicians respond individually to all the citizens who have filed a comment or objection. The administrative process is usually delayed because of the large volume of comments and objections that usually have to be managed during the public review of the plan and the limited number of technical staff in small municipalities. Thus, the rapid management of comments or objections is essential to cut down the time needed for plan development and approval, which is on average 8 years, but can last up to 15 years. The draft plan approval stage, which includes submission and resolution of comments and objections, is one of the most time-consuming stages.

The system presented in this paper was applied to the public review of the draft land use plan of Guitiriz (http://laborate.usc.es/Sigui), which took place between 16 June and 14 July, 2009. Application of the system was possible because the municipal plan was jointly developed by a planning company and the research group that developed the PPGIS at the University of Santiago de Compostela. The results are presented in the following section.

3.1. Evaluation of the system

From a total of 775 comments and objections, only 18 were submitted online through the PPGIS presented in this paper. Thus, most objections were filed using traditional participation methods, despite the time-space flexibility provided by PPGIS (considered particularly useful for citizens who reside outside the municipality). The low rate of online submissions can probably be explained by the fact that registration of the objections in the town hall remained compulsory. In addition, the website that hosted the system was not widely publicized. Indeed, the municipal website in Guitiriz did not even include a hyperlink to the application.

Nevertheless, the modest results obtained in applying the new technologies to public participation in the planning process under study are consistent with those reported by other authors in similar studies. Rinner (2001) cited a number of implementations in different European countries in which online contributions ranged from 0.1 to 6% of all contributions. Other authors report that a reasonable number of visitors query the on-line information, but very few submit contributions online (Rinner, 2001; Poplin, 2012b). Analysis of the number of registered users who submitted comments or objections (83) and the number of entries in the web system (725 during the period of public review) confirms the same trend in the case study.

Analysis of the place of residence of citizens who filed comments or objections (Table 1) revealed that most of the citizens who submitted an objection through the PPGIS reside outside the municipality (72%), whereas the proportion decreased to 40% when the total number of comments or objections filed using both methods was considered. Likewise, registered users mainly reside outside of the municipality (60%). These results confirm that the time-space flexibility provided by the system is particularly useful to non-residents.

Of all the submissions of comments and objections to the PPGIS, 15 did not attach any document, one of them attached one document and another one attached three documents. In all cases, the attached documents were land use maps obtained from the viewer and manually corrected. The percentage and type of documents attached to comments or objections submitted through the traditional method was similar.

Place of residence	**Comments or objections filed using PPGIS**	**Comments or objections filed using traditional methods**	**Citizens registered in the PPGIS**
Guitiriz	4 (22.2%)	426 (55%)	33 (39.8%)
Other municipalities in Galicia	13 (72.2%)	310 (40%)	42 (50.6%)
Rest of Spain	1 (5.6%)	39 (5%)	6 (7.2%)
N/A	-	-	2 (2.4%)

Table 1: Place of residence of citizens who submitted comments or objections and place of residence of registered users

Considering that rural settlements (i.e. small urban settlements in rural areas) represent a particular type of urban land characteristic of Galicia, most comments and objections submitted using the two methods concerned urban land (about 80%), whereas only 20% concerned rural land (Table 2).

Land use category	**Comments or objections filed using PPGIS**	**Comments or objections filed using traditional methods**
Urban	60%	34%
Rural settlement	20%	47%
Rural	20%	19%

Table 2: Percentage of comments or objections per land use category

Almost 80% of the comments and objections submitted by the traditional method concerned a change in land use (Table 3). This proportion decreased to 60% for comments and objections filed through the PPGIS. However, change in land use is the most important reason for objection. The other comments and objections submitted through both methods referred to a variety of issues, and none of them reached large numbers. For comments or objections submitted by the traditional method, the most important reasons for objection were related to the inclusion of elements in the catalogue of heritage-protected elements, cartographic changes and particular urban planning issues such as volumes, alignments or proportion of developable land. Similarly, the only reasons for the objections submitted on-line through the PPGIS were cartographic changes and modifications to the proportion of developable land.

Analysis of traditional comments or objections, which were more numerous and varied, indicated that only 1.3% were suggestions, which reveals the low level of involvement of citizens in the planning development process.

There were no significant differences between the reasons for objection according to land use category. The most common reason for objection in all of the categories was a change in land use.

Reason	Municipality		Urban land (Guitiriz)		Urban land (Parga)		Rural land		Rural settlement land	
	Traditional method (%)	PPGIS (%)	Traditional method (%)	PPGIS (%)	Traditional method (%)	PPGIS (%)	Traditional method (%)	PPGIS (%)	Traditional method (%)	PPGIS (%)
Classification of land use	79.1	60	69.9	33	91.9	0	84.1	100	93.1	100
Catalogue	5.7	0	0.8	0	2.7	0	5.9	0	2.5	0
Infrastructures	2.0	0	3.3	0	2.7	0	2.7	0	0.2	0
Cartography	2.5	20	2.0	33	0.0	0	4.1	0	1.1	0
Proportion of developable land	0.6	20	1.2	33	0.0	0	0.0	0	0.2	0
Volume	3.0	0	11.0	0	2.7	0	0.0	0	0.2	0
Alignments	1.2	0	4.9	0	0.0	0	0.0	0	0.0	0
Suggestions	1.3	0	1.2	0	0.0	0	0.9	0	0.3	0
General issues	1.0	0	0.0	0	0.0	0	0.9	0	0.9	0
Missed deadline	0.5	0	0.4	0	0.0	0	0.5	0	0.3	0
Other reasons	3.1	0	5.3	0	0.0	0	0.9	0	1.2	0

Table 3: Reasons for objection

Most of the comments and objections concerned with changes in land use requested a change to a land use category with a greater potential for development (e.g.

from developable land to urban land, or from rural land to rural settlement land) or a lower protection level (e.g. from rural natural spaces to common rural land).

3.2 Evaluation of the public participation process

The comments and objections submitted through the PPGIS were automatically added to the system database, whereas those filed by the traditional method were added to the system by technicians in order to automate responses, generate reports and statistically analyse the whole set of comments and objections filed by citizens. The largest number of comments and objections involved the main urban settlements in the municipality, i.e. Parga and Guitiriz, and the rural settlements with the largest population, such as Vilares and Pígara (Fig. 5).

Overall, 40% of the comments and objections were accepted, 13% were partially accepted and 47% were rejected. In other words, 53% of the comments and objections submitted by citizens had an effect on the final definition of the land use plan. Below, we describe the main changes applied to the comprehensive land use plan of Guitiriz derived from public participation.

For urban land, the largest number of changes corresponded to variations in the delimitation of urban land. Such changes were incorporated in the plan because the citizens who filed the objections demonstrated that the plots of land affected met the legal criteria for classification as urban land, including electric power infrastructure or water supply and sewage networks.

The situation was similar for the land classified as developable land. Most comments or objections concerned the existence of urban design elements that were not included in the cartography of the plan. The layout of the utility infrastructure and the urban road network was adjusted accordingly, and the appearance of land classified as developable land varied because of some changes to urban land.

For rural land, most objections sought to classify plots as rural settlement land. Most of the plots affected were those with a dwelling, located near a defined settlement area. Some of the objections were accepted because the plots met the legal criteria for delimitation of rural settlements, but other claims were rejected. Indeed, most of the objections that requested a change in land use from rural to urban were rejected because the plots did not meet the legal criteria, except in some cases in which the required infrastructure was built during the long planning development process. A third group of objections requested a change in rural land use, usually from agriculture use to forestry use, or from water protection or natural space categories to agriculture or forestry use. Most of the objections in this group could not be accepted because the definition of the categories was based on the legislation, on current and past use and on the suitability of the land for each category of use.

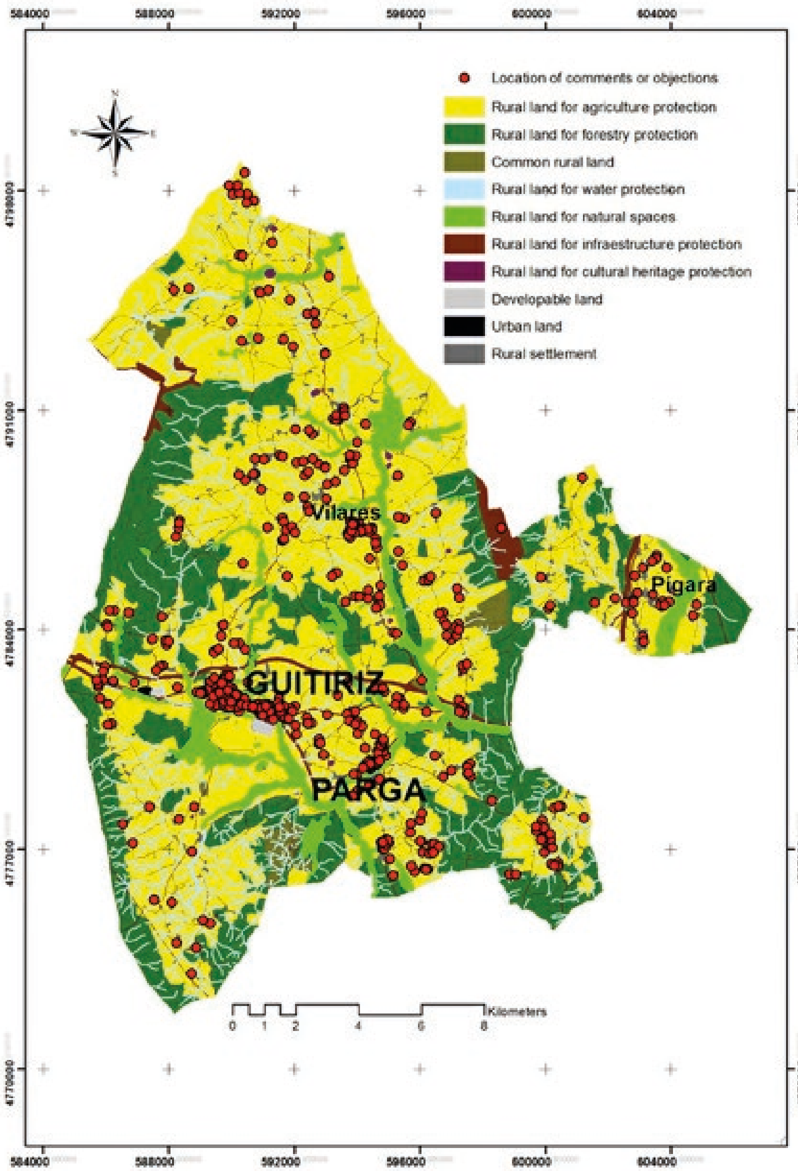

Figure 5: Location of objections and land use category

Only a small number of comments or objections affected rural land for natural spaces, a category that should be of particular interest in a municipality in which a large part of the land belongs to a biosphere reserve. However, a number of quarries and companies involved in the stone industry requested changes from their current category to rural categories with a lower level of protection, which is legally impossible.

Analysis of the reasons for filing a comment or objection shows that public participation mechanisms are not fulfilling the original aims of public intervention, i.e. to guarantee a fair distribution of the benefits and disadvantages derived from planning processes, to prevent the overexploitation of resources and to promote the common good (Fiskaa, 2005). Consequently, new public participation mechanisms must be developed and added to the mechanisms envisaged in the legislation. The new mechanisms should promote public participation beyond the mere evaluation of decisions that have already been made and involve citizens in decision-making processes as well as in designing alternative plans (Plein et al., 1998).

4. Conclusions

In this paper, we present a web-based PPGIS aimed at helping citizens comment on or object to a land use plan and encouraging community involvement in the development of the plan. The PPGIS improves access of citizens to information on urban planning processes and on the state of development of the plan, and it speeds up the management process by automating the analysis of and response to comments and objections by technicians. The tool thus promotes equal participation in local planning and guarantees transparency in the development of the plan (e-democracy). The system contributes to empowering the community by providing equal access to information by all sectors of the community and gives the process legitimacy and accountability. With regard to the four roles of citizen participation suggested by Ball (2002), i.e. consultation, advisory, review/comment and decision-making, the system enables full achievement of the first three roles and makes the fourth role easier to achieve to a certain extent.

The forms used to submit comments and objections, the length of the stages of planning development and the available information vary widely in different municipalities. For this reason, we have designed an easily adaptable and customizable application by using software development frameworks and splitting the system architecture into three layers, which separate the business logic from visualization of the processed data. The PPGIS presented here is a cost-effective multiplatform tool that can be easily adapted and extended because it is based on free software, architecture design patterns, development frameworks and widely used GIS and WEB tools. The modular structure of the system enables changes in specific components without any need to modify the remaining ones, and it gives the system portability and expandability, so that it can be easily adapted to the inherently different needs of the municipalities. Moreover, because most of the municipalities in Galicia are small, with low numbers of inhabitants and limited budgets, the use of free software is the best option, insofar as it involves considerable savings in license costs and enables distribution and implementation across other organizations without additional expenses or licensing. An additional advantage is access to the source code, which offers the possibility of customizing the application for each municipality in order to adapt it to specific requirements. Moreover, because geographic data acquisition is a costly task, making the vast amount of data generated during the development of the plan available to the public increases the usefulness of the information insofar as it can be used for this or other purposes.

Application of the system to the stage of public review and comment in the comprehensive land use plan of Guitiriz revealed a low level of use of the system. The study findings confirm the conclusions drawn by Stern et al. (2009) regarding the inability of web-based participation to replace traditional techniques, even though web-based participation is an effective complementary means of public participation. However, the poor uptake observed in the present study can probably be explained by two main factors: first, registration of all comments and objections in the town hall was compulsory; and second, the system website was poorly publicized. In future implementations, the system website should be made public through brochures, local newsletters and local community centres. Nevertheless, the system is particularly useful for citizens residing outside the municipality because it provides them with access to the relevant information and it enables them to participate in the plan development process from any location at any time, (although all participants would still be required to register at the town hall their online comments/objections).

Review of the documents attached to the comments and objections provided by citizens, mostly land use plans with manual corrections, revealed the need to extend the capacity of the system in order to enable citizens to modify or digitize land use maps or other maps related to the local plan. The system is currently being extended to enable the implementation of more proactive mechanisms of public participation.

The need for new public participation mechanisms was also revealed by analysis of all the comments and objections to the plan (submitted either by the traditional method or through the PPGIS), which were incorporated into the system database. The results of the analysis demonstrate that land use zoning is the main concern of citizens, who seek greater potential for development or lower levels of protection for their land. Consequently, future research should focus on promoting different public participation mechanisms that enable intervention at additional stages of the planning development process through the web-based PPGIS. To this end, the functionalities of the application must be extended and new capacities included to enable citizens to design alternative plans.

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Models and Techniques for Land Use Simulation and Planning: Case Studies in Galicia

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Abstract
The complexity, slow development and implementation of urban and regional plans are due, among other factors, to the limited technological and technical capacity of both public and private entities to undertake these processes. The application of land use simulation and optimization models, using geographic information technologies, can provide support to spatial planning processes such as land analysis and diagnosis and optimal land use allocation. In addition, the integration of Geographic Information Systems (GIS) in these types of models and techniques in order to support different stages of spatial planning has given rise to the emergence of Planning Support Systems. This paper overviews some such tools developed by the Land Lab of the University of Santiago de Compostela: an urban cellular automata model adapted to the characteristics of the small population settlements in Galicia; several algorithms aimed at rural land use allocation; and two Planning Support Systems - one based on a proprietary GIS and a more recent one completely developed with free open source software. The application to several case studies in Galicia demonstrated the capacity of these tools to provide more realistic, scientifically justified land use plans while reducing the time, effort and resources required for this task.

Keywords: Land use optimization, land use allocation, urban cellular automata, optimization heuristic algorithms, planning support systems.

1. Introduction

The complexity, slow development and implementation of urban and regional plans are due, among other factors, to the limited technological and technical capacity of both public and private entities to undertake these processes. Methodological and technological innovations are needed to facilitate both the technical elaboration and evaluation of the plans. The application of land use simulation and optimization models by using geographic information technologies can provide such support to spatial planning processes.

Spatial planning is the process whereby a target land model is designed on the basis of previous land analysis and diagnosis, and the measures required to construct the model are defined. Different methods and techniques can be used to analyse and classify the land system and to design the target land model.

Regarding land analysis and classification, knowledge of Land Use/Cover Change (LUCC) and analysis of its spatial extent and pattern, as well as quantification of past changes and projection of future trends are all essential tasks. Analysis of these processes enables estimation of the impact of LUCC and planning of the future land use.

LUCC models can be used to study and explain the causes and consequences of land use dynamics by analysing the physical and socioeconomic drivers of land use patterns (Verburg et al., 2004). These uses, together with their capacity to generate land use scenarios under different conditions and to evaluate the impact of each scenario, make LUCC models a powerful support tool for designing land use policies and plans. Depending on the specified objective, these models may be descriptive, explanatory or predictive.

The various LUCC models available are based on different techniques. Initially these models were based on economic theories focused on modelling economic processes linked to land use change (Irwin and Geoghegan, 2001). Subsequently, spatially explicit economic models were developed, which usually incorporate economic theories into spatial models of land use change, such as Cellular Automata (CA)based models and Agent Based Models (ABM). Both CA and ABM models are examples of so-called dynamic models and are currently the most frequently used LUCC models. Both are also bottom-up models, i.e. they rely on the interaction between individuals and their environment in order to model the behaviour of complex systems. Although they are very simplified abstractions of reality, these models can provide a greater understanding of the general characteristics of urban and land use dynamics (Li, 2011). The rationale underlying these models is that modelling the behaviour of individuals is easier than modelling the system as a whole. Moreover, modelling the behaviour of individual agents can reveal workings at the system level (Sugumaran and DeGroote, 2011).

CA based models are especially relevant because of their ability to reproduce complex spatial and temporal dynamics at global scale by using local rules. These rules operate in the neighbourhood of a grid cell that represents the space where the simulated processes take place. Transition rules are applied in discrete time steps and determine the state of each cell (land use) according to the state of neighbouring cells. The wide dissemination of CA models can be explained by their simplicity, flexibility and transparency, as well as by their capability to incorporate the spatial and temporal dimension of processes and their easy implementation in Geographic Information Systems (GIS; Santé et al., 2010). The design and application of an urban CA model adapted to the characteristics of the small population settlements in Galicia is described in this chapter.

Once land analysis and classification have been carried out, spatial planning involves designing the target land model, i.e. generating alternatives, solutions and spatial planning scenarios that determine the best location for land use types and activities in a particular area. Methods that can be used at this stage of the spatial planning process include(i) optimal location models, which provide the ideal location for a facility or activity, (ii) land suitability evaluation methods, which assess the suitability of the whole study area for a specific land use or activity, and (iii) methods for the spatial allocation of multiple types of land use, which combine the suitability for different type of land use to simultaneously allocate all of these types and produce an 'optimal' land use map.

The final group of methods includes algorithms for optimization of spatial allocation of land use, thereby facilitating one of the most complex tasks in the spatial planning process, i.e. the allocation of land use categories to each land unit in order to define a land use map. This process can be defined as a problem involving multiple and conflicting objectives in which a large number of spatial units are involved, and heuristic optimization algorithms must therefore be used to obtain a near optimal solution. Some such algorithms designed and applied in Galicia for rural land use allocation are described in this chapter.

The integration of GIS in the different types of models and techniques that support different stages of spatial planning has given rise to the emergence of Planning Support Systems (PSS; U.S. EPA, 2000; Brail and Klosterman, 2001; Geertman and Stillwell, 2004; Brail, 2008; Geertman and Stillwell, 2009; Geertman et al., 2013). The conversion of a GIS into a true decision support system implies expanding its analytical capabilities by including data exploration methods and modelling techniques, which, in the case of Planning Support Systems, correspond to land use planning techniques. These decision support systems are designed to provide an environment to explore, structure and solve complex spatial problems, thus improving the level of understanding of the problem and helping to better redefine it, by analysing potential conflicts and trade-offs between objectives to ultimately generate and evaluate possible solutions.

Planning Support Systems are information technologies developed to support spatial planning, and they operate at the crossroads between various disciplines (e.g. geography, spatial planning and ICT). These systems comprise a wide variety of geotechnological tools (GIS and spatial modelling) aimed at supporting spatial planning processes (Geertman and Stillwell, 2003). They have been defined as geoinformation technologies devised to explore, represent, analyse, visualize, project, prescribe, design, implement, monitor and discuss issues associated with the need for planning (Batty, 1995). Planning Support Systems technology is still at an early stage of development, as demonstrated by the broad diversity of systems available and the lack of standardization (U.S. EPA, 2000; Brail and Klostermann, 2001; Geertman and Stillwell, 2003; Geertman and Stillwell, 2004; Santé and Crecente, 2006). More recently, the application of GIS and GIS-web in public participation processes has given rise to Public Participation GIS or PPGIS, which are addressed in the final chapter of this book. In this chapter, two Planning Support Systems developed by the Land Lab of the University of Santiago de Compostela are described - one based on a proprietary GIS and a more recent one developed completely with free opensource software.

2. Case studies in Galicia

2.1. Urban Cellular Automata Models

Most of the CA-based land use simulation models were originally designed and evaluated for large urban areas, where urban growth processes and drivers are easily identifiable and definable because growth is greater than in small settlements and consequently more data are available for model calibration. In small population settlements, such as those that predominate in Galicia, urban growth is slow, making the application of this type of models difficult because fewer data sets are available for the calibration (García et al., 2012). García et al. (2012) compared the ability of some of the main urban CA models to simulate the urban development of a medium size urban settlement in Galicia (Ribadeo), which had undergone considerable urban growth in recent years. Some of the most widespread and well-known models were used in this study: several of the family of models proposed by White and Engelen (White at al. 1997), SLEUTH (Clarke et al., 1997; http://www.ncgia.ucsb.edu/projects/gig/) and the model developed by Wu (2002). The results (Figure 1) indicate that the models that simulate various categories of land use, i.e. those that model urban and non-urban land uses, such as the family of models of White and Engelen (White et al., 1997; Engelen et al., 1999; Barredo et al., 2004), better capture the land use dynamics in this area. However, these models require more complex and reliable calibration methods that can capture growth dynamics from small amounts of data.

Due to the difficulties in applying existing CA based models in Galicia, García et al. (2013) designed an urban CA that uses statistical techniques and a genetic algorithm for improved calibration, which facilitates adaptation of the model to the specific characteristics of the small population settlements in Galicia. The model proposed by Garcia et al. (2013) is based on that of White et al. (1997) but includes two new features: are duction in the number of the calibration parameters by statistical techniques, and calibration of the remaining parameters by means of a genetic algorithm. This simplifies the calibration process while improving the ability of the model to capture growth dynamics. On the other hand, the model of White et al. (1997) was modified on the basis of the results of the study of García et al. (2011), which proved that an exponential function such as that used by Wu (2002) enabled better control of the degree of stochasticity introduced in the model. Likewise, the factor that controls land use suitability was scaled using a βcoefficient to model the relative importance of suitability relative to the neighbourhood factor. Finally, some restrictions were included in the transition rule to exclude certain areas for specific types of land uses in order to consider urban planning constrictions or the presence of elements that prevent the land use change (e.g. cemeteries, churches, landfills, etc.). These modifications led to the development of the following equation to calculate the transition potential of each type of land use:

$$P_{hj} = R_j \times v \times s_j^B \times (1 + N_j)_j + H_j$$

$$v = \exp\left(-\alpha \times 1 - rand)\right)$$

$$N_j = \sum_d \sum_i m_{kjd} I_{id}$$

Where P_{hj} is the transition potential of each cell with land use *h* to land use *j*; R_j is the set of restrictions for land use *j*; *α* is a coefficient that controls the degree of randomness; *rand* is a random number; N_j is the neighbourhood effect; H_j is an inertia parameter that models the resistance of land use *h* to a change to land use *j*; m_{kjd} is a coefficient that indicates the influence of land use *j* of each neighbouring cell with land use *k* on the distance *d*; and I_{id} is 1 if cell*i* at distance *d* is occupied by land use *k* and 0 otherwise.

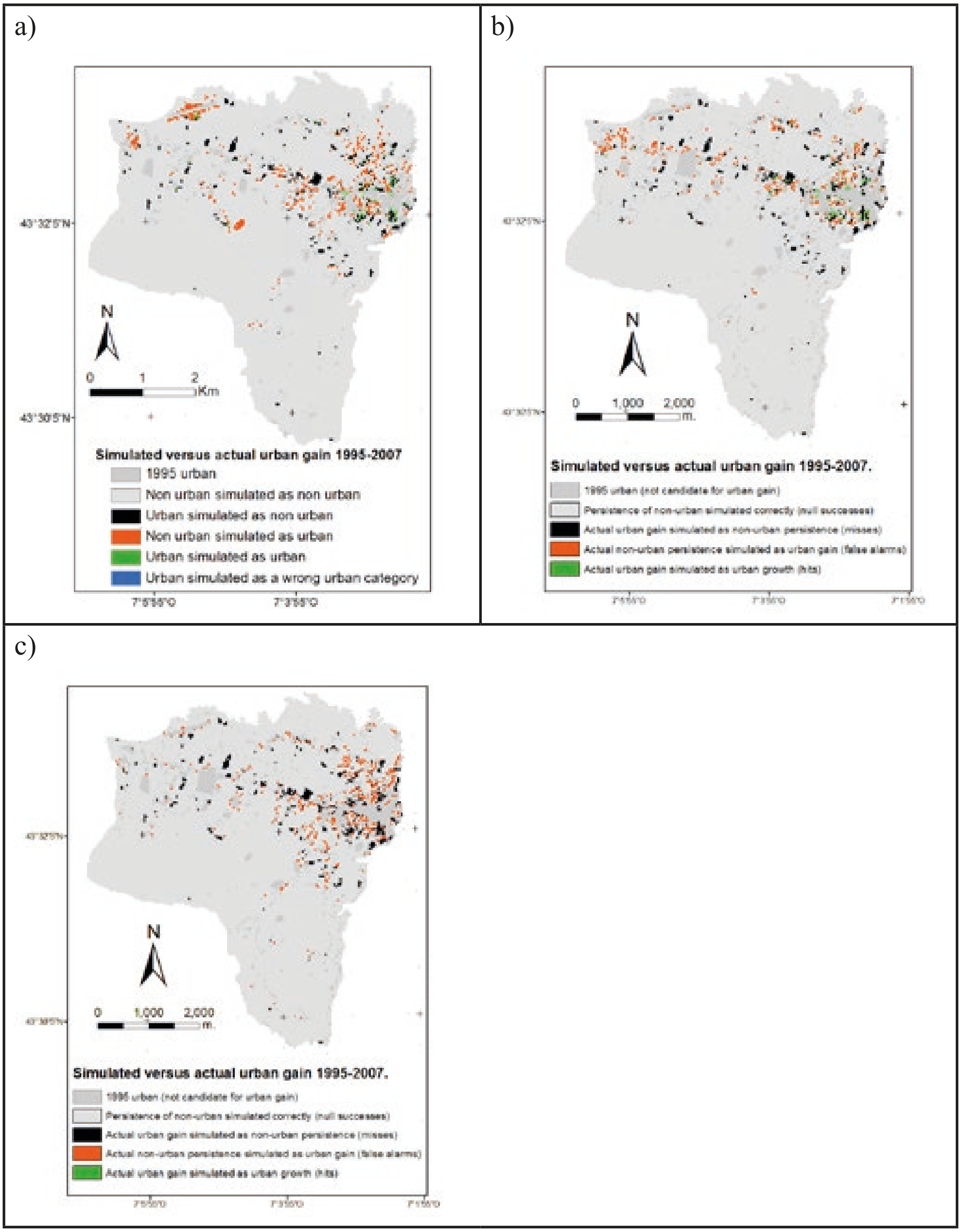

Figure 1: Results of applying (a) the model of White et al. (1997), (b) SLEUTH and (c) the model of Wu (2002). Source: García et al. (2012)

A reduction in the number of calibration parameters by simplifying the neighbourhood effect (N_j) equation was needed to facilitate the CA calibration by the genetic algorithm. For this purpose, the influence of each land use depending on the distance (x) of the cell in the neighbourhood was represented by means of two lines (Figure 2). Thus, instead of calibrating a coefficient m for every pair of land uses and each distance, only four coefficients should be calibrated for each land use (a, b, c and d).

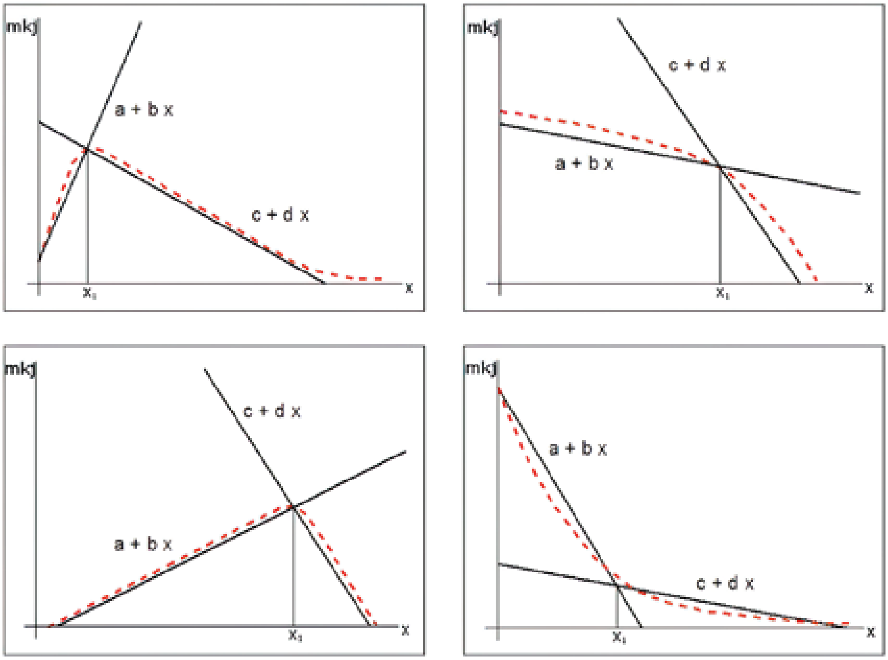

Figure 2: Simplification of distance-decay functions using two linear functions. Source: García et al. (2013)

The model calibration was also simplified by calculating the suitability factor (s_j) by logistic regression. Thus, the coefficients calibrated by the genetic algorithm are α, β, H_j and the four coefficients that define the linear functions that model the influence of each land use based on the distance withing the neighbourhood.

Modelling urban growth in the municipality of Ribadeo with this CA model provided better results than those obtained with the models of White et al. (1997), Wu (2002) and the SLEUTH model. Subsequently, the applicability of the model for decision making on urban planning was tested in Guitiriz, another municipality in Galicia. This study simulated the urban growth of the main town of Guitiriz in order to identify the areas with the highest probability of development and to compare these areas with the most valued natural spaces, thus locating natural areas at risk of development (Figure 3). The results of this analysis can be taken into account in urban planning in order to steer urban growth towards less sensitive areas and design a land use plan that protects natural values.

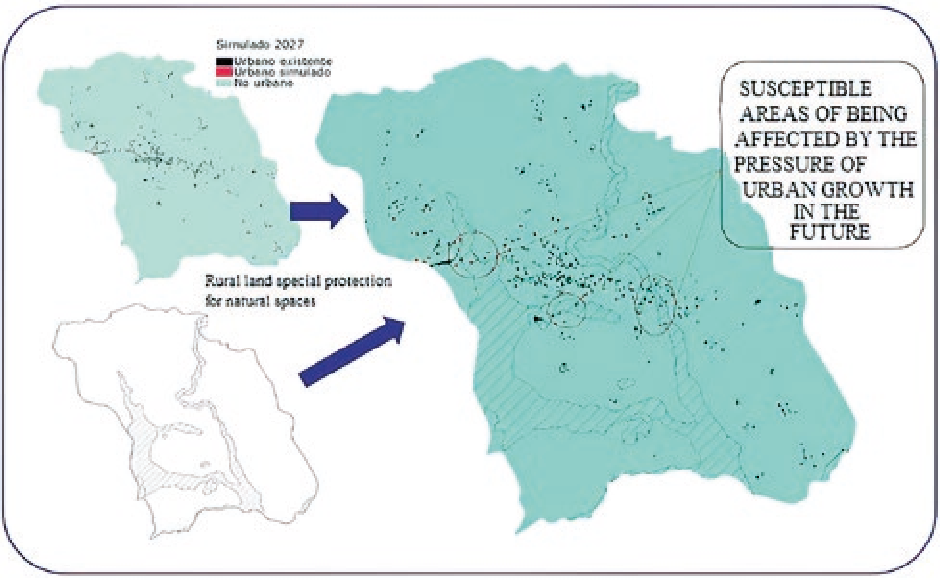

Figure 3: Natural spaces in the municipality of Guitiriz at risk of urban development. Source: García et al. (2011)

2.2. Algorithms for optimization of spatial allocation of land use

The process of allocating the optimal land use to each land unit can be presented as a problem in which I square spatial units of one area unit must be distributed among N different land uses, under the constraint that the total area assigned to each land use n is a given number I_n, where $\sum_n I_n = I$ and also where the suitability A_{in} of each spatial unit I for each land use n is known and, optionally, a set of weights w_n that indicate possible preferences among land uses.

This problem can be easily implemented in a raster GIS by equating each spatial unit to a cell of a raster map. Thus, the first algorithm designed by the

Land Lab for rural land use planning in Galicia was implemented in a raster GIS and was based on simulated annealing (Santé-Riveira et al., 2008a). The objective function of this algorithm included three terms: maximization of suitability of land units for the allocated uses, maximization of compactness (minimization of fragmentation) of the total area allocated to each land use and maximization of compactness of the total area allocated to specific groups of land use types defined by the planner.

This algorithm was used by Santé-Riveira et al. (2008a) for the spatial allocation of 13 types of rural land uses in the region of Terra Chá, an area covering 1,832 km^2 in inland Galicia, which was represented by a raster map with 4,339,725 cells of 20x20 m. The results obtained by this algorithm for different weightings of the three terms of the objective function were compared with other three techniques: two multicriteria evaluation techniques -hierarchical optimization and ideal point analysis (Barredo et al., 1996); and the MOLA (*Multi-Objective Land Allocation;* Eastman et al., 1995) optimization algorithm of IDRISI (Figure 4). These three techniques only consider the suitability maximization, without taking the spatial pattern of land use into account. For this reason, the results obtained with these techniques were compared with those obtained by the simulated annealing when only the first term of the objective function was used. Simulated annealing was found to provide the solution with the highest total suitability value but with a much more fragmented spatial distribution of land uses than that provided by the other techniques. However, assigning the same weight to the three terms of the objective function predicted a more compact spatial pattern of land use and a higher total suitability than those predicted by the other three techniques.

However, in the actual practice of spatial planning land use, zoning usually follows the physical footprints on the land and property, i.e. the cadastral plots. The above described algorithm operates on a raster map, and it can therefore lead to the allocation of multiple land use types to a single plot or to groups of plots with very different characteristics in the same area. For this reason, the aforementioned algorithm was implemented in a vector model that enables use of cadastral plots as land units for the spatial allocation of optimal land use, resulting in the new tool described by Santé et al. (2016).

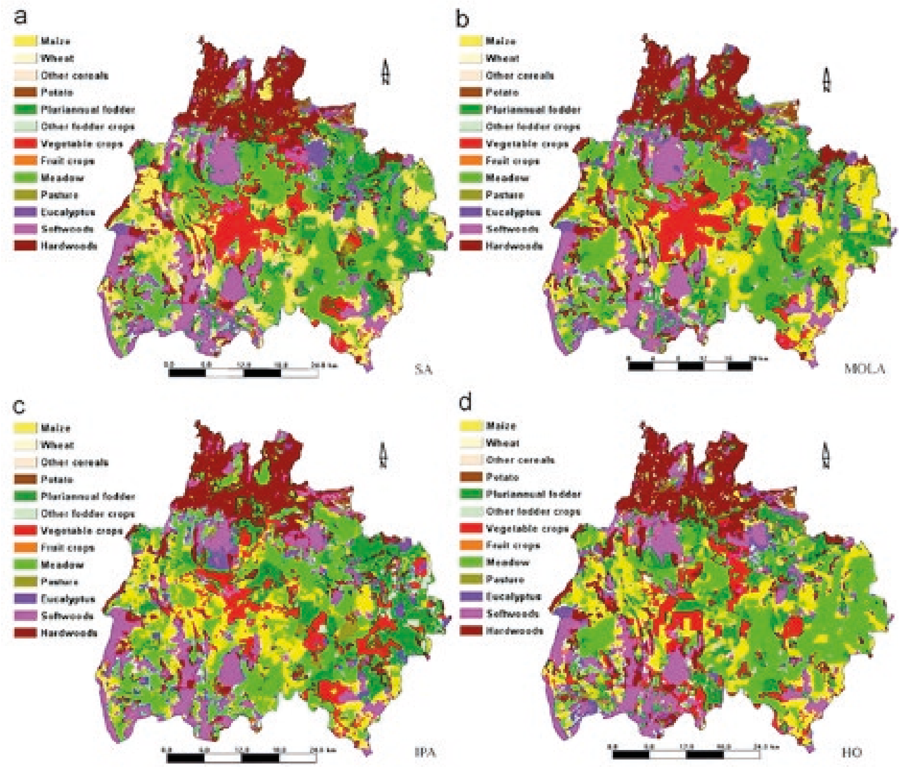

Figure 4: Results provided by the algorithm based on *simulated annealing* (a), MOLA (b), ideal point analysis (c) and hierarchical optimization (d) for rural land use planning in the Terra Chá, Galicia. Source: Santé-Riveira et al. (2008a)

This new algorithm entailed higher computational costs that required parallel implementation. The use of parcel polygons instead of cells of a raster map implied the use of complex compactness metrics based on geometric characteristics (area and perimeter) of groups of plots, which must be recalculated each time the algorithm is run. This made it necessary to parallelize the algorithm code in order to reduce the execution time for geometric parallelization (Ding and Densham, 1996), which involved dividing the spatial domain into subregions that can be managed by different processes. In this algorithm only two terms of the objective function were implemented: maximizing suitability and maximizing compactness. Two spatial metrics were used to evaluate compactness: one based on patches, i.e. groups of adjacent plots with the same type of land use, and one based on categories, in which plots are grouped into categories.

The solutions obtained by applying this algorithm to urban and rural land use planning in the municipality of Guitiriz (Figure 5) were compared with the land use map of the Comprehensive Land Use Plan of Guitiriz. This map was designed by planners without the support of any computer tool and including the same land use suitability maps used as input for the algorithm. The results showed that the solutions provided by the algorithm improved the overall suitability achieved in the allocation of plots to different land use types, compared to the solution designed by planners. In terms of compactness, the best solution corresponded to that developed by planners, but the algorithm achieved very similar compactness values when the compactness was based on categories. However, the main advantage of the algorithm was not the high value obtained for suitability, but the possibility of obtaining a land use map based on a justified and transparent procedure requiring much less time than required by planners.

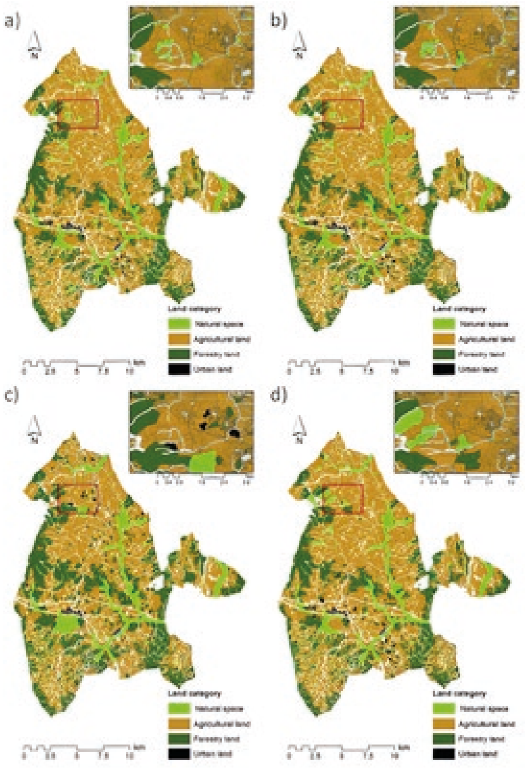

Figure 5: Results of algorithm based on *simulated annealing* for urban and rural land use allocation to cadastral plots in Guitiriz by using the compactness function based on categories and weights of a) 0, b) 0.5, c) 1 and d) 0.99. Source: Santé et al. (2016).

With the aim of improving the results obtained by the aforementioned algorithms, a new algorithm was developed on the basis of a heuristic optimization technique, which was being applied in other fields with great success but had still scarcely been applied in land use planning: genetic algorithms. A genetic algorithm was designed that operates on cadastral plots to allocate the optimal land use type considering the maximization of suitability and compactness (Porta et al., 2013a). As in the previous case, parallel programming was required in order to achieve efficient execution times. In this case, three different parallelization paradigms were analysed: multi-core parallelization, cluster parallelization and a combination of both.

In the genetic algorithm, each individual gene represents a label that identifies the type of land use allocated to the corresponding parcel. Individuals have a number of genes equal to the number of plots. This implies a very large number of genes, which made it necessary to ensure optimal memory usage by developing data structures that reduce data access time. The quality of the individuals was assessed through a fitness function that considers two components (suitability and compactness), and the roulette-wheel technique was used to select individuals for the next generation, so that fitter individuals have a higher probability of being chosen. The techniques used to generate new individuals (new land use maps) were the crossover technique, which randomly selects two different genes from the genotype and swaps the genes of both parents between those two positions, and the mutation technique, which randomly selects genes that change until a certain mutation rate is reached. Application of this algorithm to the aforementioned case study in the municipality of Guitiriz, which includes 138,175 cadastral plots, produced good results relative to the solution designed by planners (Figure 6).

Even though all of the algorithms described above can potentially be applied to both urban and rural land use, most of the studies carried out by the Land Lab, both in research projects and in actual land use plans or urban plans, used these algorithms for rural land use allocation. Urban planning sometimes requires consideration of factors in addition to land suitability, which must be incorporated into the land use optimization model. In Galicia this particularly applies to rural settlements, an urban land category characteristic of Galicia and which is specifically regulated by Galician urban planning law. Thus, the particular restrictions placed on this land use category are based on its spatial pattern metrics (distances and densities). For this reason, an optimization algorithm was specifically developed for the spatial planning of this urban land category, which enables the urban planning law and other additional technical criteria to be taken into account for the spatial delineation of different categories of rural settlements (Porta et al., 2013b).

Figure 6: Land use map produced by the genetic algorithm in the municipality of Guitiriz. Source: Porta et al. (2013a).

Although the original idea was to design a genetic algorithm, the specific problem conditions eventually led to the development of a population-based iterated greedy algorithm, which operates on the cadastral plot to delineate two categories of rural settlements: traditional-historical rural settlements and common rural settlements. The algorithm implements the legal constraints for this type of urban land category, which are based on calculating the building density rate in the delineated rural settlement areas. However, the algorithm enables the building density rate to be calculated by the method recommended by the regional public administration or by applying a method based on the calculation of a "characteristic mean distance." The algorithm also applies other constraints such as the maximum area of a rural settlement, based on estimated population settlement growth, or the minimum number of buildings.

The objective function optimized by this algorithm includes six terms: (i) maximization of the suitability of plots included in the rural settlement delineation, where the suitability depends on the plot characteristics (slope, aspect, land use and proximity to roads, public spaces, water network and other facilities) and on the buildings included; (ii) compactness; (iii) building density in traditional-historical rural settlements; (iv) building density in complete rural settlements; (v) ratio between the traditional-historical area and the maximum theoretical area of the rural settlement; and (vi) ratio between the area of the complete rural settlement and its maximum theoretical area.

Figure 7: Spatial planning of traditional-historical and common areas in the rural settlement of Saa (Guitiriz) provided by the population-based iterated algorithm. Source: Porta et al. (2013b).

The algorithm was validated by application to the spatial planning of several rural settlements in the municipality of Guitiriz, which were selected for their very different morphological characteristics and spatial patterns (Figure 7). The results show that the algorithm provided solutions that meet the legal criteria while optimizing the technical criteria included in the objective function. In addition, modifying the input parameters of the algorithm enabled efficient generation of alternative delineations of the same settlement complying the legal requirements. This ability enables planners to select the spatial planning alternatives that best fit the specific requirements and characteristics of the different types of rural settlements, as well as to test the consequences of the selected parameter values (types of buildings considered, distance between buildings, method of calculating the building density rate, etc.) for a better understanding of the morphology and characteristics of settlements.

2.3. Planning Support Systems: RULES and OpenRULES

The first algorithm described in the previous section, based on simulated annealing and operating on a raster model, was implemented in a Planning Support System called RULES (*RUral Land-use Exploration System*) (Santé-Riveira et al., 2008b.), which is RULES aimed at rural land use planning, RULES supports three stages of the land use planning process (Figure 8): (i) land suitability evaluation, (ii) optimization of total area of each land use; and (iii) spatial allocation of land use. RULES was programmed on the basis of a proprietary GIS, GeoMedia Professional, and LINDO API was also used for the linear programming model.

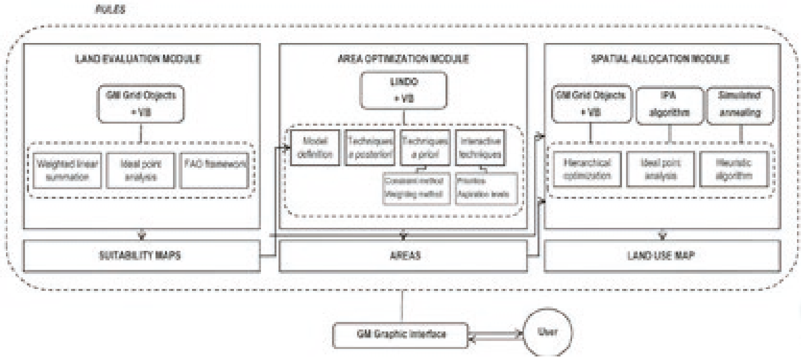

Figure 8: Framework of the three modules of RULES. Source: Santé-Riveira et al. (2008).

RULES implements two multicriteria evaluation methods and the FAO framework (FAO, 1976) for evaluating land suitability. The second module applies a multi-objective linear programming model (Santé and Crecente, 2007), which optimizes the area of each land use according to six economic, social and environmental objectives. The suitability maps and land use areas resulting from the above modules are used as input data in the third module in order to design the final land use map by means of three techniques: hierarchical optimization, ideal point analysis and an algorithm based on simulated annealing (Figure 9).

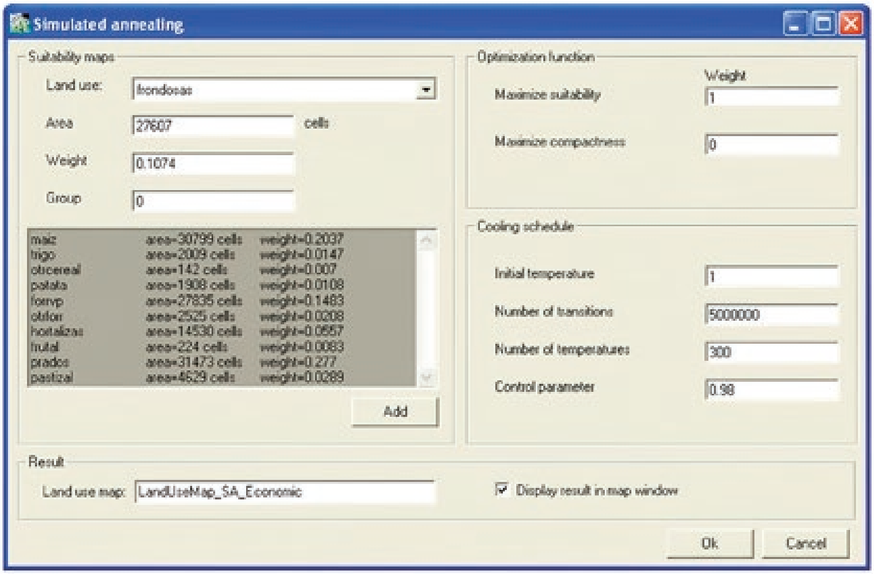

Figure 9: RULES interface for applying the land use optimization algorithm. Source: Santé-Riveira et al. (2008).

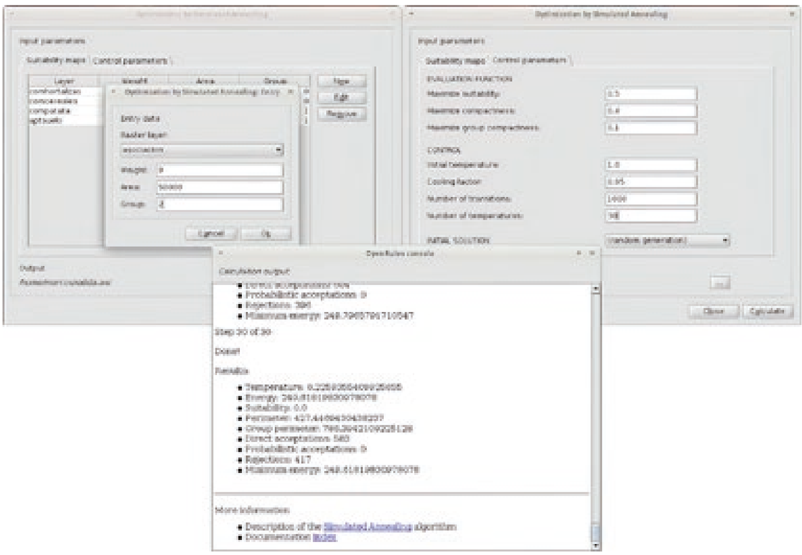

Figure 10: OpenRules interface for applying the land use optimization algorithm. Source: Santé et al. (2016).

More recently, the RULES-based OpenRules system (Santé et al., 2016), which exclusively uses free opensource software, was developed by improving and adding functionalities. Among these improvements, the possibility of using an unlimited number of factors for land suitability evaluation and the incorporation of a new objective in the optimization algorithm of spatial land use allocation are particularly important. OpenRules was programmed in Java and implemented as a module of the free GIS gvSIG, with full integration between the GIS and the decision support tools (Figure 10).

3. Conclusions

It is important to point out that the objective of all these techniques is not to provide a single ideal or optimal solution with the aim of removing the planner from the process, but rather to provide a support tool to assist in the decision-making process, without replacing the human input. The main contribution of all these tools is their ability to generate different planning alternatives according to different objectives, parameters and criteria. Thus, the main goal is to support the decision-making process through a better understanding of the problem and the consequences of each decision.

The models and techniques described in this chapter help to provide more realistic, scientifically-justified land use plans that include a large number of analytical factors while reducing the time, effort and resources required for the task. These tools also make both the decision-making process and the results of the process more transparent and accessible. In short, use of analytical techniques such as those described in this chapter, which have a well-developed theoretical basis, facilitates: (i) the efficient generation of large numbers of planning solutions, which, once evaluated by planners, will provide better knowledge and understanding of the problem addressed, enabling a feedback process that in an iterative way will contribute to improving the solution finally adopted, (ii) the justification of the solution adopted, as the criteria and decisions that lead to designing the solution can be explained, and, consequently, (iii) increased transparency of the land planning process.

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"What should we do with the land we have?" With this question Rafael Crecente inspired an entire community of researchers, practitioners and policy makers. His mission? To build bridges between scientific fields as well as research and action in order to approach land management in a holistic and inclusive way. His vision motivated and influenced multiple projects and initiatives in Galicia, Europe and South America. Founder and director of the Land Laboratory (LaboraTe) and Masterterra at the University of Santiago de Compostela, to name but a few achievements, he was considered one of the great land management experts in Galicia. His curiosity, passion, leadership and determination attracted both young students and senior researchers alike. This helped establish Rafa's most valuable legacy – a collective of knowledge and practice dealing with the biophysical, institutional, social, economic and spatial realities of land. A group of people dedicated to working towards a more sustainable future both at a local and global level. As Rafa would often say, in order to improve the learning experience, one should: "Integrate and transcend." Part of that community has graciously contributed to this book. They were all given one brief – to summarize the most valuable knowledge and wisdom gathered throughout their academic careers. The land management wisdom they would like to transfer to future generations. That Rafa's legacy has inspired these observations and will help to meet individual and collective land challenges is somehow the most fitting tribute.

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