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A GLOBAL PERSPECTIVE ON CADASTRES & GEO-ICT FOR SUSTAINABLE URBAN GOVERNANCE IN VIEW OF CLIMATE CHANGE

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A GLOBAL PERSPECTIVE ON CADASTRES & GEO-ICT FOR SUSTAINABLE URBAN GOVERNANCE IN VIEW OF CLIMATE CHANGE

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Abstract

In the near future global environmental issues, such as ensuring clean air, water, no pollution and assuring the future sustainability of our planet and its resources will drive developments in land use changes, transport policies, energy and carbon pricing and other climate change mitigation and adaptation policies. Urban and peri-urban areas hugely affect global climate change since they consume as much as 75% of commercial energy; generate as much as 80% of all waste and 60% of greenhouse gas emissions³. We argue that in view of climate change the need and demand for the collection, management and use of reliable spatial information and communication technologies (or Geo-ICT) intensifies to assure the integrated sustainability of the policies used to tackle global, national and local environmental issues. Based on three case studies (the Dutch Kadaster, HeatMap Overlay and the Solar Atlas of Berlin) and a review of recent empirical and policy literature, our findings support the view that cadastres and land registration organizations have an important role to play as part of a wider spatial information infrastructure in adapting and mitigating climate change in cities as a core and part of a wider spatial information infrastructure essential for sustainable urban governance.

1. Introduction

In the wake of the United Nations Climate Change Conferences in Copenhagen in December 2009 and in Cancun in November 2010, there is nowadays a widespread recognition that while the efforts to avert serious climate change have ran out of steam, on a global scale the effects of climate change have become visibly impossible to be put under control or reverted. The reality is that the human race must not only accept, but also live with climate change as best as it can.

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³ These figures were presented at the 2010 XXIV FIG International Congress on 'Facing the Challenges – Building the Capacity' (for further details please visit: <http://www.fig.net/pub/fig2010/>).

This recognition equally affects the developed as well as the developing world, which following the Copenhagen accord proposed that \$ 100 billion per year should be given from rich to poor countries by 2020 to be equally divided between investment in climate change mitigation and adaptation strategies. Such vast resources to be invested are not the only transfer which rich countries are expected to provide to poorer countries. Other investments will also include know-how and crucially also their own examples of sustainable urban governance policies and practices, including policy development and planning as well as the evaluation and monitoring of cities energy efficiency, flood defense, zoning and spatial planning laws as well as land development plans and technological means that can be used to effectively implement those strategies and investments.

We argue that in view of climate change the need and demand for the collection, management and use of reliable spatial information and communication technologies (or Geo-ICT) intensifies to assure the integrated sustainability of the policies used to tackle global, national and local environmental issues. Based on three case studies and a review of recent empirical and policy literature focussing on energy efficiency in urban areas, our findings support the view that cadastres and land registration organizations have an important role to play as part of a wider spatial information infrastructure in adapting and mitigating climate change in cities as a core and part of a wider spatial information infrastructure essential for sustainable urban governance, which is identified as the main contribution of this paper.

The rest of the paper is as follows. The next section reviews the literature on climate change, cadastres, urban governance and Geo-ICT. Next, we present the research design for the global case studies on the evaluation and monitoring of cities energy efficiency and the policy implications of this study. Conclusions follow.

2. Climate change, cadastres, urban governance and Geo-ICT

The links between climate change, cadastres, urban governance and Geo-ICT are complex. According to Grimmond (2007), globally the impact of cities on climate change at the regional and local scales is of greater magnitude than projected global scale climate change, which can have severe impacts on the planet and the human species.

The latest Synthesis Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) states that the climate system is unequivocally warming: *as it is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and the rising of the global average sea level.* As a rough estimate, this could result in more precipitation in the north, more droughts in the south, fewer cold days, more hot days, heat waves and higher sea levels. As a secondary effect, the IPCC expects many natural systems to be affected, such as glacial lakes, early spring events, bird migration, and shifts in plant and animal species towards the Polar Regions, salinity and earlier greening of vegetation. Various scenarios show the impact on human systems and a number of areas of increased vulnerability for both urban as well as rural residents are highlighted such as crop productivity, coastal zones, flood plains, health, industry and settlements prone to extreme weather events and drought.

According to the IPCC (2007) the largest growth in greenhouse gases emissions between 1970 and 2004 has come from energy supply, transport and industry in urban areas. The urban environment therefore needs attention: *about 30-40% of the total energy consumption in western countries is assigned to buildings. About 50% of these refer to the energy consumption for indoor air conditioning (heating and cooling)* (Pulselli et al, 2009). Regarding the effects of climate change on the built environment Roberts (2008) clarifies that buildings play an important role in both adaptation and mitigation. Modern building design includes low carbon running costs while *maintaining comfort*. Super insulation, high performance windows, heat recovery systems, thermal storage are to be included in climate proof design principles. Hamza and Greenwood (2007) reports about the role of building regulations in the UK, which originally were introduced to safeguard public health and safety, but now -after revision- are seen as a tool for *limiting the environmental impact of the built environment on natural resources*. Therefore, cities become the first cornerstone for a full scale test of feasible options to at least adapt if not mitigate the effect of climate change.

According to Simon (2007) the most rapid growth within cities is occurring in poor and middle-income countries and at rates that are far in excess of the historical rates recorded in the global North. In the developing world, and more specifically in Africa, increased water stress, reduced rain-fed agriculture, affected low-lying coastal areas and diminished access to food are expected. Asia is expected to suffer from decreased availability of fresh water, higher risk for delta areas and pressure on natural resources. Europe is expected to be faced with floods and erosion, glacier retreat, reduced availability of water, worse weather conditions in the south, and increased health risks because of heat waves and wildfires. The Americas are expected to be prone to gradual replacement of tropical forests by savannah, loss of biodiversity, decreased livestock and crop production, less precipitation, heat waves in the north and increased rain-fed agriculture.

According to the Royal Commission on Environmental Pollution of the UK (RCEP, 2010) it is clear that steps must be taken to reduce greenhouse gas emissions on a global scale. Yet there has not yet been a clear set of actions that countries around the world should try to implement at that scale to improve our understanding of the pace and scale of climate change as a first step to find better ways to address it. Our suggestion in this paper is that that geo-ICT, cadastres and land registration organizations have an important role to play as part of a wider spatial information infrastructure in adapting and mitigating climate change in cities as a core and part of a wider spatial information infrastructure essential for creating sustainable urban governance dynamics (Navarra and Bianchi, 2013). A UN-ECE report on Social and Economic Benefits of Good Land Administration (UN-ECE, 1998) suggests the following parties have an interest in enabling the re-use of cadastral information for sustainable urban governance in view of climate change:

- National governments: Administration, taxation, economic development, market information, and international harmonization;
- Local governments: Spatial planning, land valuation & use, land management & information;

- Companies and citizens: Security of rights, social stability, access to housing through mortgage finance, market opportunities and potential for investments and development, mobility and property transfer.

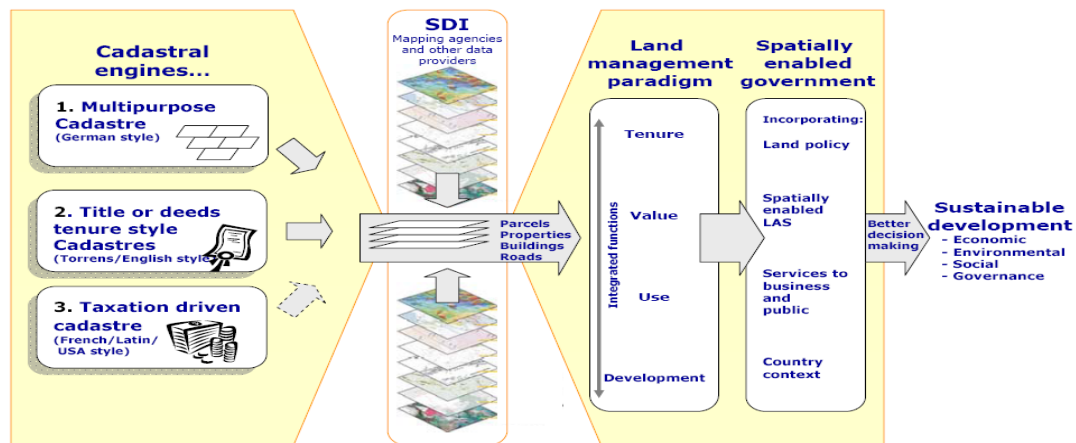
Throughout the world different organisations of cadastral systems exist. Two main types of cadastral systems can be identified: the deeds system and the title system (Zevenbergen, 2002). The differences between the two concepts relate to the extent of involvement of the state, and to the cultural development and judicial setting of the country. The key difference is found in whether only the transaction is recorded (deeds systems) or the title itself is recorded and secured (title systems). Deeds systems provide a register of owners focusing on *who owns what* while title systems register properties presenting *what is owned by whom*. The cultural and judicial aspects relate to whether a country is based on Roman law (deeds systems) or Germanic or common-Anglo law (title systems) (FIG, 1995).

Even though cadastral systems around the world are clearly different in terms of structure, processes and actors, their design is increasingly influenced by globalisation and technology (Van der Molen and Lemmen, 2003). The same influences push land rights and land use towards integrated, multifunctional information systems or Geo-ICT, which also reflect urbanisation trends and public sector reforms incorporating decentralisation, marketisation, efficiency and accountability and transparency (Navarra, 2010). Geo-ICT is the end result of the combination between geographic (or spatial, geologic, geodetic, geometric, etc.) information and Information and Communication Technology (ICT). Geo-ICT include Geographic Information Systems (GIS), Land Information Systems, Spatial Decision Support Systems (SDSS), Spatial Data Infrastructures (SDI), Spatial Information Infrastructures (SII) and other geographic information and communication technologies, which are generally advocated to contribute to the efficiency and effectiveness of the organization of government as a way to improve public sector governance, for instance, by increasing the availability and accessibility of government's services as well by improving general planning, coordination and cooperation (Navarra, 2010a and 2010b).

Van der Molen and Wubbe (2007) highlight the importance of Geo-ICT when the public administration, private sector and citizens decide on issues where the spatial component is one of the determinants of decisions. For instance when there is a need to access relevant spatial information, and could contribute in a meaningful way to the process of spatial decision making. Without these digital facilities, modern governments cannot understand the built environment of cities, manage land efficiently, utilize computer capacity to assist policy making, or retrieve significant value out of land. In the latter circumstances the value that can be considered important for public sector governance would be safeguarding the reliability, availability, access and use of spatial information for the fulfillment of societal objectives. Within this context, a land administration system or cadastre can be seen as a spatial information infrastructure which supports the management of land and spatial planning for the purpose of sustainable urban governance. The processes of land administration include regulation of land and property development to control the creation of new interests in land, the use and conversion of land, the gathering of revenue from land through sales, leasing, and taxation, and the resolution of conflicts concerning the social interests, ownership and use of the land (Dale and McLaughlin, 1988).

According to Williamson, Enemark, Wallace, Rajabifard (2010), the role and significance of the cadastre and land registration authorities rests with the usefulness of the large scale cadastral map as a tool able to expose a *representation of the human scale of land use and how people are connected to their land.*

Figure 1. Significance of the Cadastre



Source: Williamson, Enemark, Wallace, Rajabifard, 2010.

As it is possible to see from Figure 1, the digital cadastral representation of the human scale of the built environment and the cognitive understanding of land use patterns in peoples' farms, businesses, homes, and other developments form the core cadastral information sets enable a country to build an overall administrative framework to deliver sustainable urban development. However, although the authors stress a difference between land information and land administration systems, they seem to acknowledge only a limited role (namely a tool) to Spatial Data Infrastructure (i.e. SDI) based digital representations. Thus even if Geo-ICT represent an important node of the spatially enabling of government towards sustainable urban development, it is arguable that only SDI would be able to provide the in depth analytical capabilities required to produce sustainable development in the economic, environmental, social and governance dimensions identified by the authors. And there are two main issues that have not been fully acknowledged by the above research: 1) the dozens of datasets (from utility infrastructure to topography) available are not only produced by the public, but also by the private sector; 2) such overabundance of spatial information has not yet been aptly put in use to increase the effectiveness of land governance in the public sector or to measure the progress towards urban sustainability.

Spatial planning, as an expression of the existence of a well functioning cadastre, can then be highly coordinated between different relevant socio-economic objectives (Navarra and Bianchi, 2013). For example, for the development of transportation systems, local economy and housing, but also nature development, water management, agriculture and other activities with a strong environmental component (Biesbroeka et al, 2009; Navarra, 2010ab). Cadastres ultimately document certain interests in land, including information about the nature and spatial extent of

interests on it, and the names of the individuals to whom these interests relate. There are multiple benefits from a reliable land registration system providing secure land ownership, combating poverty as well as climate change. Bennet et al (2008) study for instance outlined how land information can be enable sustainable land administration by organising new property interests such as carbon credits and water rights. Whereas Van der Molen (2009) articulated the important role cadastral can play for addressing the world's most pressing concerns, which can be declined in terms of urban governance: sustainability and climate change (Bennet et al, 2010). The afore mentioned applies also to the possible role of cadastral registration of energy labels as providers of information to the government on energy management.

3. Research design for global case studies on the evaluation of cities' energy efficiency

Since more than 80% of energy used in households is dedicated to space heating, large savings are expected to be gained by introducing appropriate climate change adaptation and mitigation policies in the housing stock. In order to monitor energy use, several countries introduced different ways to assess the environmental rating of buildings. Sweden for instance investigates the external and an internal factors affecting buildings CO₂ and other emissions (Malmqvist et al, 2010), while Denmark, Belgium, the Netherlands, Germany publish so called energy labels, in order to create awareness amongst the populace concerning energy use of houses and potential savings.

However, an investigation in Denmark reveals that energy labeling is not an immediate success as energy savings were found to be insignificant despite it was the main goal of the Danish Energy Labelling Scheme (Kjærbye, 2008). In addition, an investigation by a national real estate agent association (VBO) in the Netherlands revealed that only 38% of house buyers paid attention as whether an energy label was available for the property they were interested in (Dutch News, 2009). Nevertheless, very few countries around the world (if any) have taken concrete measures that would combine new geo-ICT and other measures to assess and eventually improve the environmental rating of buildings and labeling but also to implement climate change adaptation and mitigation strategies at city level. The case studies that will follow are intended to illustrate how such a move may become possible in the future.

This paper's research design aims to use desk research to provide a global perspective and case studies which explore how cadastral can apply geo-ICT to support sustainable urban governance in view of climate change and to identify the role of land registers and cadastral in adapting to and mitigating climate change. As far as the authors are aware, this area still represents a wide gap in our knowledge.

3.1 Case study 1: The Dutch Kadaster

As one of the signatory parties to the Kyoto Protocol, the Netherlands' government recognizes the urgency and scale of the global climate challenge: its goal is a 30% reduction in greenhouse gas emissions by 2020, relative to the benchmark year of 1990, preferably as part of a European effort. In view of the fact that 50% of the land area in the Netherlands is located below

sea level, it is no surprise that coping with the rising average seawater level, the higher run-off and discharge predictions for the major rivers and extreme precipitation forecasts is a priority. However, the government realizes that measures to cope with water management should be coupled to measures on land use, nature conservation, urbanization, transport and recreation. Therefore, the National Adaptation Policy is based on the concept of integrated land-use planning, which combines objectives of sustainable coastal defense measures, supplemented by robust river water systems, sustainable cities, climate-proof buildings and climate-proof agriculture. The Dutch Kadaster also supports land acquisition by the government in order to implement anti-flooding measures. The land consolidation expertise available at Kadaster is put into practice when the government aims at realizing better climate-proof agricultural business structures as well as sub-catchments for river water. As a consequence of sea level rise, seawater will also penetrate further into the estuaries of the Rhine and Meuse, causing salt intrusion leading to high salt concentrations. In this area as well, Kadaster provides relevant land information to support land-based anti-salinization spatial planning.

Since January 1, 2008, legislation has entered into effect that requires an energy label to be available at the time of transactions related to the construction, sale or letting of houses and buildings. The energy label issued for a specific house provides information about the energy consumed during its standardized use. The registration of energy labels of buildings is a result of the implementation of the Energy Performance Building Directive (EPBD). In this directive the European Union has implemented the obligation to make an energy performance certificate for residential and utility buildings available for the prospective owner. This obligation was implemented with the direct aim of promoting the energy performance of buildings and is effective for all member states of the European Union (Brounen and Kok, 2011).

In the Netherlands this legislation has been implemented since January 2008. An energy label is now required during sale, letting or construction transactions of real estate. The energy labels are registered in the registers of the Dutch Cadastre and as such publicly available. These energy labels form a new category in the land registers. To date, the Dutch Kadaster has registered about 50.000 labels. Starting with the core data, cadastral parcels, buildings and ownership rights it is possible to attach relevant information attributes and design these into coherent and tailor-made information packages. These information packages can be used in the context of the policy issues as for climate change policies and energy policies (Vranken and Broekhof, 2012). The energy labels are open for public inspection, as is all cadastral data. Kadaster supports the government in providing not only all information about land tenure, value and use of land and houses, but also about public properties and environmental limitations regarding use, noise, soil pollution and nuisance.

3.2 Case study 2: Heat Map Overlay

Up to a quarter of heat generated in houses can be lost through buildings' roof and can account for much of total energy consumption in urban areas resulting in higher fuel and energy consumption as well as higher levels of emissions that can negatively affect climate change. Accurate thermal loss data in buildings visualized using geo-ICT can therefore provide a first important step towards geo-referenced heat-loss maps giving both a view of energy use at peak times as well as the possibility to identify urban areas mostly affected by heat loss.

One such experience is Heat Map Overlay or Home Energy Assessment Technologies, combining software, hardware, data provision and a web-portal service that enables free-of-charge, automatic assessment of domestic waste-heat footprints by simply clicking on a house in Google Maps. Although it is only available as a pilot project in selected areas of Alberta (Canada) in future could also be used also to evaluate energy efficiency of the entire city. According to a recent article on the initiative (Hay et al, 2010) on entering the site the user sees a Community HEAT Map overlaid on Google Maps, representing a continuous waste-heat surface defined within the civic boundaries of each community. This surface is created through an interpolation of the average roof top temperatures of each house, which are differentiated according to ten classes, from cold (blue) to hot (red). This scale allows evaluation of multiple communities at a glance.

Heat Map Overlay help also to identify the top ten thousand-plus hottest houses in an area, enabling planners and policy makers to evaluate and compare the energy efficiency of different communities allowing them to formulate more informed advice for instance for sponsoring energy-saving retro-fit incentives, focused repairs on weaker parts of a roof and to verify the effectiveness of post-renovation. Citizens can enter information about the material of the roof directly to determine the material's emissivity: a measure of the material's ability to radiate absorbed energy, which in turn allows accurate, and house-specific energy consumption and saving modeling. Finally the graphical user interface enables the retrieval of house area from the city's cadastral data and determines a fuel table model, which can be used to estimate the costs per day of heating based on the roof's temperature using several types of fuel, but also total monetary and green-house-gas footprint costs and savings per year for each house.

3.3 Case study 3: *The Solar Atlas of Berlin*

Another interesting European case study of the application of geo-ICT for the efficient use of energy and to foster the development of renewable sources of energy is the Solar Atlas of Berlin. Based on initial calculations for the German city of Berlin, which suggested that about two thirds of the entire energy consumption and small businesses could be generated on the city's roofs, the implementation of the Solar Atlas of Berlin has three main objectives.

The first objective is to display the location of existing solar installations in the city; the second objective is to visualise the potential of the solar industry in Berlin and finally the third objective is to highlight rooftops suitable for solar panel installation. In order to calculate the city's potential for solar energy production and installations down to the individual building a comprehensive and realistic 3D city model integrated to the solar atlas was developed. According to the project's description (Berlin Partner, 2011): "to create the model, the city's about 500.000 buildings in area of 890 km² were surveyed using aerial photography, and their roofs were measured with lasers. In addition, detailed models were created for about 80 landmarks, five of which can even be explored from the inside (Olympic Stadium, Sony Center, The Reichstag Building, DZ-Bank, and the Central Train Station)".

For each suitable area the 3D model allows the calculation of solar energy potential by combining data on insulation, roof size, potential electricity generation, potential CO₂ savings,

power in kilowatts and investment volume. This makes it possible for both owners and investors in real estate to find out whether or not the roof of a building is suitable for use as a source of energy, and whether or not such an investment would be sensible. The atlas, which was first implemented in two pilot areas with a total of nineteen square kilometers, is now on-line and free to access by residents was especially designed and developed for home and business owners.

4. Policy implications

Adaptation to and mitigation of climate change, by their very nature, challenge professionals in the fields of urban planning and governance, land use, land management, land reform, land tenure and land administration to incorporate climate change issues in the new direction of urban and land governance. As we have discussed earlier, geo-ICT can be used in a broad range of city functions, for urban design and management as well as for the development, implementation and monitoring of evidence based policies for the evaluation and monitoring of cities energy efficiency.

Regarding adaptation to the effects of climate change, the construction of new buildings resistant to weather extremes like flooding and storms, require not only new construction methods, but also a land use planning that allocates building construction at the right location (Roberts, 2008). The case studies we explored in this paper aim to show how geo-ICT can be used to minimize detrimental land use transitions in urban areas to reduce emissions within the already existing housing stock. Land registers and cadastres have an important role as a sound information base to provide accurate information about the existing land tenure pattern for the implementation of land management policies for sustainable urban governance. In summary, land registers and cadastres have a role to play in supporting governments and citizens in their efforts to mitigate climate change and in trying to develop policies and strategies for adaptation to its impact.

Cowie et al (2007) sees potential synergies between existing multilateral environmental agreements and the implementation of land-use change and land management to adapt to and mitigate climate change. The basic idea is that land-use change and land management can be used to increase the terrestrial carbon pool, which at the same time contributes to the Biodiversity Convention (CBD) and the Desertification Convention (UNCCD). This means that in addition to appropriate registration of land tenure and cadastral geometry, additional information is required about environmental rating of existing buildings, their energy use, current and potential land use related to carbon stock potential and greenhouse gases emissions, flood and storm prone areas, salinization rates and transport indicators. This information might not necessarily be recorded in the land registration and cadastre system itself, but at least connected with it, so that a strong link with private and public rights to land remains in existence. For a summary of the global environmental issues, impact on urban areas and policy implication discussed in this paper please refer to Table 1.

Table 1. **Global environmental issues, impact and policy implications**

Global environmental issues	Impact on urban areas	Policy implications
Global environmental change	More precipitation in the north, more droughts in the south, fewer cold days, more hot days, heat waves and higher sea levels.	Draw on spatial information and communication technologies to minimize detrimental land use transitions in urban areas (i.e. with respect to the quality of soils, water balance or habitat quality at specific locations).
Energy consumption and emissions	Urban heat islands, productivity, consumption, land use plans and zoning, development of urban processes and urban spaces that contribute to green real estate markets.	In addition to appropriate registration of land tenure and cadastral geometry, information about environmental rating of buildings, energy use, current and potential land use related to carbon stock potential and greenhouse gases emissions, is required for issuing rules and recommendations for public managers, building engineers and citizens (i.e. 'energy pass').
Consistent and reliable evaluations of energy use in buildings for compliance with building regulations, for buildings energy performance certification and interactions between different areas of urban management	Multi-level governance interactions and responses impact on urban systems (such as transport, utilities, water, waste collection, etc.) and how the responses to these impacts are shaped by the interactions between socio-economic and geo-political processes.	Providing the spatial information infrastructure to calculate the integrated energy performance of buildings, for sponsoring energy saving retro-fit incentives and changes in taxation for communities with high heat loss and accurate house-specific energy modeling in support of sustainable development.
Achieving sustainable urban development	Rate, intensity and scale of urban and environmental change, mutual impacts between public and private urban areas, land use transitions.	Promote institutional arrangements, legal frameworks, fiscal incentives, processes, standards and 3D models to support new land development strategies (i.e. land zoning, allocation, evaluation and monitoring for greening real estate markets) and deliver meaningful information to citizens and decision makers.

Source: Own elaboration.

Finally, to encourage sustainable urban development in view of climate change cadastres as part of government should become more active in developing focused policy measures with the aid of geo-ICT in three areas of urban planning and governance and especially in infrastructure planning, energy efficiency for adaptation and mitigation and green building developments. The following are the policy implications of this study:

- Policy makers should draw on geo-ICT (or other spatial information and communication technologies) to minimize detrimental land use transitions in urban areas (i.e. with respect to the quality of soils, water balance or habitat quality at specific locations);
- Cadastres and geo-ICT can provide the spatial information infrastructure to calculate the integrated energy performance of buildings, for sponsoring energy saving retro-fit incentives and changes in taxation for communities with high heat loss and accurate house-specific energy modeling and to produce consistent and reliable evaluations of energy use in buildings for compliance with building regulations, for building energy performance certification purposes;
- Institutional arrangements, legal frameworks, fiscal incentives, processes, standards and 3D models to support new land development strategies (i.e. land zoning, allocation, evaluation and monitoring for greening real estate markets) and deliver meaningful information to citizens and decision makers should be promoted as key approaches to develop climate change mitigation and adaption policies and for sustainable urban governance dynamics (Navarra and Bianchi 2013).

5. Conclusions

This paper has presented a global perspective on cadastres and geo-ICT for sustainable urban governance in view of climate change. We have reviewed both recent academic and policy literature in this area and illustrated three case studies to suggest equitable and efficient ways of reducing carbon emissions in urban areas by increasing energy efficiency. The Dutch Cadastre has created a new category to register energy labels. Relevant information attributes were designed to develop coherent and tailor-made information packages which can be used for better climate change and energy policies. In the case of Heat Map Overlay, this is achieved by the possibility to develop ad hoc area based incentives targeted to communities with a high heat loss. With regards to the Solar Atlas of Berlin the 3D model allows the calculation of solar energy potential by combining data on insulation, roof size, potential electricity generation, potential CO₂ savings, and power in kilowatts and investment volume in a suitable area. Both case studies provide an alternative to implement climate change adaptation and mitigation strategies at city level.

The literature and the cases show that cadastres should become more committed as part of a wider geographic information and communication technology infrastructure in making sure that buildings, transport, city infrastructure and urban design must be simultaneously climate resistant, energy efficient and carbon neutral. We are aware that climate change is also affected by other greenhouse gases, pollutants in the atmosphere and other ways in which humans are changing the Earth's climate – including the effects of deforestation. Reducing carbon and other pollutants emissions will require realistic international and global agreements as well as new approaches to national policy. The alternative approach discussed in this paper could help to improve both the content and prospects of climate change policies and actions not only in the area of energy efficiency in urban areas, but possibly in other areas too.

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