Collaboration of Science, Practice and Citizens in the Field of Climate Change Adaptation, supported by Interactive GI-Tools

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Abstract

Within the framework of the research project "BebeR", a cross-sector approach has been chosen to decide on measures aiming at adapting to climate on a local level, aimed at mitigating soil erosion. Cross-sector means to consider possibly all relevant actors that play a role during the development of measures to adapt to climate change. Such a collaborative approach should help to avoid unsustainable decisions. The provision and integration of various spatial datasets plays a crucial in such a framework, but also the consolidation of different meanings about pathways to effective climate change adaptation. The consideration of expertise from different sectors is significant when making decisions. The integration of relevant information from different sources can be supported effectively using online participation tools, including GI-technologies, e.g. interactive online mapping. Many of the actors dealing with climate change problems collect, analyse and visualize spatial data intensively. In such a way, geoinformation and resulting maps become important means to support decision making on the one hand, and achieve consensus under explicit consideration of different contextual perspectives, on the other. The collaborative approach and the GI-technologies used will be presented. Conclusions and next steps complete the paper.
Keywords: Collborative GIS, Participation, Web-GIS, Climate Change Adaptation

1 Introduction

From 2013- 2016, with a follow-up scheme starting in 2017, the pilot project "Klimpass-Aktiv" has been carried out, aimed at the development of a local adaptation strategy to climate change. The project included the prioritization and implementation of measures that were envisaged to be grounded on a cross-sector decision making process. Such sectors can be, for example, urban planning, agriculture, forestry, soil protection, disaster management, water management, enterprises, industry and the public. Cross-sector means to consider possibly all relevant actors that play a role during the development of measures to adapt to climate change. Such a collaborative approach should help to avoid unsustainable decisions. These can be due to insufficiently considered interdependencies between sectors or the under- or overrepresentation of sector-specific peculiarities. Even the total ignorance of sectors can cause difficulties later on or might lead to inadequate decisions.

However, governmental administrations must reflect climate change adaptation as a task that concerns, in many cases, not only one sector, e. g. water management, forestry, agriculture or urban planning. Measures to mitigate negative consequences of climate change require the knowledge and expertise of different actors from various sectors (Figure 1). Taking into account the interdependencies between sectors means to support cross-sector thinking which is essential *before* decisions are made or even implemented.

Within the project "BebeR", a collaborative approach has been chosen to achieve the common development of suitable climate change adaptation measures to mitigate erosion in river catchments. Erosion can occur due to extreme weather events, e. g. heavy rainfall, as they are expected to happen increasingly in future due to climate change. To support collaboration of different actors from a variety of sectors a website has been implemented which contains information about climate change and related data on the one hand, but foremost participative tools that support actors in two directions:

(1) An Online and Interactive Mapping System which can be used to

- to gain information not only about the "own" sector, but also about others, thus being able to get knowledge about the spatial characteristics in different sectors effectively
- to use the data interactively, integrate them cross-sector-wise, and to produce new maps, e. g. hinting on specific vulnerabilities

(2) A digital forum which can be used to

- provide data and information
- participate in discussions about planned measures
- add local knowledge that hasn't been considered so far

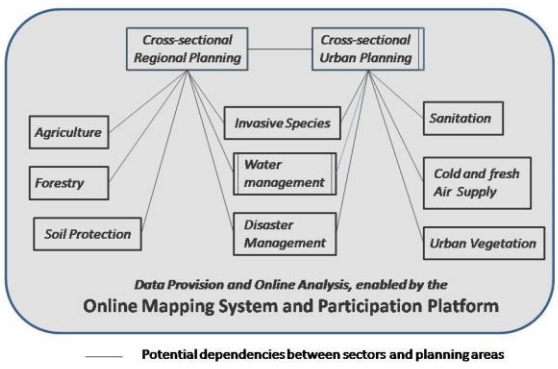
Both, the interactive, online mapping system and the forum, can be used by actors that are directly involved in the cross-sector decision-making processes, but also by citizens who can contribute data and specific knowledge or comment on adaptation measures, including suggesting new ones. Other examples of successful inclusion of citizens in finding solutions for spatial problems are documented, for instance, at (Citizen Science GIS 2018).

The online mapping system relies on the technological side on Open Layers, whereas a commercial CMS is applied to implement the digital forum. The components of the website will be presented, experiences be discussed. Some conclusions will embrace important results of the project and refer to next steps to be done.

2 Development of local climate change adaptation measures

A central goal of the project "BebeR" is the enablement of administrational employees to include adaptation to climate change into their common thinking and their daily workflows on the one hand, and to enable them and other sectors, private and public, to participate in the decision making processes about climate change adaptation measures. Figure 1 shows that the interdependencies between sectors are diverse and that their proper consideration is quite important to achieve sustainable decisions that find appreciation by all project partners, including citizens.

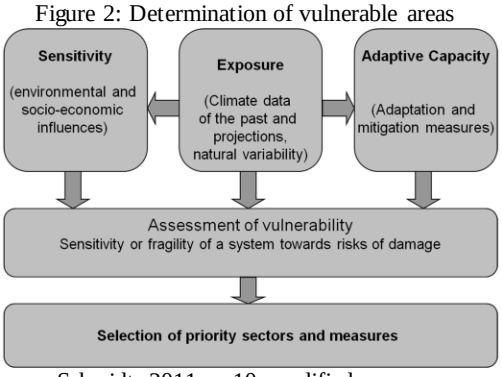
Figure 1: Exemplary sectors, working collaboratively on the assessment of climate change adaptation measures



2.1 Identification of vulnerabilities

In order to determinate consensual and prioritized measures, it has been discovered that the identification of vulnerable areas within the region is an indispensable step. Vulnerabilities have to be recognized prior to the decisions about adaptation measures. The assessment of vulnerabilities includes finding answers on the question to what extent a region is exposed to future risks. Within "BebeR", the detection of vulnerable areas has been expanded and considers an assessment of the exposure, the sensitivity, and currently executed adaptation measures, as well as the capacity to adapt in general (see figure 2). All these aspects are discussed on the basis of face-to-face workshops, but also the usage of the online mapping system, and the forum.

Figure 2: Determination of vulnerable areas



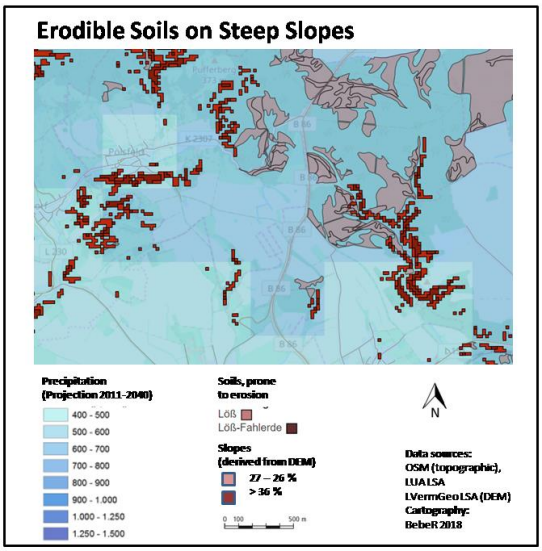
Source: Schmidt, 2011, p. 10, modified

2.2 Multi-sector assessment

It has been identified that, in most cases, vulnerabilities cannot be determined considering only one sector. The erosion of the banksides of a river, for instance, concerns the administrational unit responsible for water management, but also the farmers who cultivate land close to the river, the forestry department if trees are affected by erosion events, and regional planning as a whole. Field trips have also shown that sometimes citizens can provide important expertise concerning local specifics which initiated the consideration of citizen science approaches into "BebeR". This is only one example which shows that vulnerabilities have to be evaluated considering different sector perspectives, or contexts.

In such a way, the assessment of vulnerabilities, as a necessary step before deciding on measures, is a result of a complex appreciation of varying views, different opinions, and finally the readiness to find compromises between potentially conflicting sectors. The data required for the assessment is delivered by the online mapping system which can also be used to produce vulnerability maps, thus taking into account different layers of spatial information, e. g. soils, DEM (slopes), roads and climate projection data, as the following figure presents.

Figure 3: An exemplary vulnerability map, based on the data layers provided by the "BebeR"- online mapping system

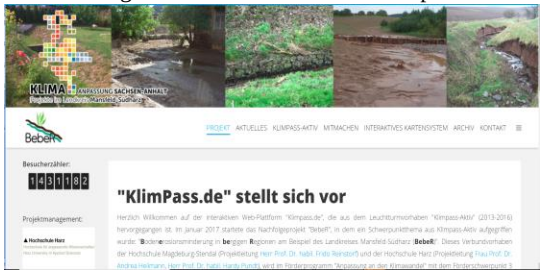


3 The "BebeR"-website

The development of a web-based platform for interactive participation of all actors has been envisaged from the beginning of the project BebeR. The functionalities of the website www.klimpass.de (figure 4) should contribute to

- the provision of relevant knowledge about climate change facts, climate data (including future projecttions),
- the linkage to other relevant websites concerned with climate change,
- the provision of GIS-functionalities, based on relevant datasets provided by concerned sectors,
- the cross-sector discussion of problems and eventually occurring conflicts during the planning phase of adaptation measures.
- In general an improved acceptance of adaptation measures by the actors, as well as the public.

Figure 4: The website www.klimpass.de



3.1 The interactive and online mapping system

Users can visualize basic layers, but they can also combine different layers, from diverse sectors, to investigate if interdependencies between sector-specific information pools exist or to analyze specific characteristics that may enable them to detect vulnerabilities or to make other important findings (Fig. 3). In such a way, the mapping system becomes an important information deliverer, but due to its interactivity it is an important participatory communication tool as well (Forrester and Cinderby 2018, Tang 2006). Figure 3 shows an exemplary vulnerability map, thus informing users about easily erodible soils on steep slopes that are prone to provoke landslides with potential to damage nearby roads when heavy rainfall takes place. It includes projected precipitation data delivered by an interpolation algorithm and provided via the Internet by a consortium that developed the system. It enables users to estimate the development of climate parameters taking into account projected climate scenarios in the future (RaKliDa 2018). Map-based results, whether they are preliminary, temporary or final, can be shared with others. The forum, however, can assist in discussing such maps. In such a way, the online mapping system and the forum support the development of cross-sector maps, explicitly taking into account varying contexts, and furthermore considering climate data and projections. Adaptation measures can be debated among all relevant actors, and alternatives can be appreciated in a scientifically sound manner. Planned measures can be accepted or refused, alternatives can be discussed. By this means, the integration of multiple viewpoints is possible via the Internet, which is an evident aspect of interdisciplinary cooperation: "(…) the internet provides a means for sharing, maintaining and disseminating data besides the possibility of conducting interactive analysis over the web to expand participatory opportunities to interested parties" (Kyem and Saku, 2009, p. 13).

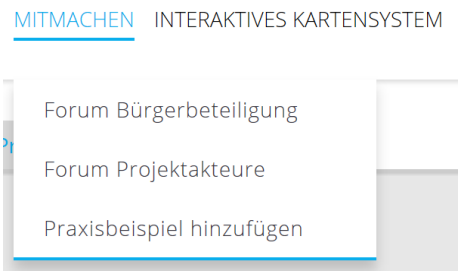
The implementation of the online-mapping system was carried out based on the open source software OpenLayers 3.x (Gratier et al. 2015). OpenLayers can be adapted by using JavaScript individually (Emrich & Marit 2015). The integration of spatial data, and the specific requirements of actors demanded for the implementation of various specific aspects for which JavaScript is a suitable programming language.

3.2 The forum

The interactive forum (accessible via the main menu, see figure 4) is an additional feature of the Klimpass platform aimed at strengthening the communication between administrational employees, scientists, and citizens (Brennan et al. 2012). All relevant groups should participate in the development of adaptation measures, and the online forum can support the cooperation between different parties if it is used comprehensively (Kyem and Saku 2009; Brown and Weber 2011). Online participation is important because the inclusion of citizens, for instance, can be vital to achieve acceptance for measures implemented by administrations. Fig. 5 presents the menu to access the forum ("Mitma-

chen") and the online mapping system ("Interaktives Kartensystem").

Figure 5: The menu to access the forum



The forum menu presents different opportunities to collaborate: Particpation of citizens ("Forum Bürgerbeteiligung"), Participation of project actors ("Forum Projektakteure"). Additionally, already implemented adaptation measures can be added by everyone ("Praxisbeispiel hinzufügen").

4 Discussion

Many local administrations realized in the meantime that climate change affects the natural, as well as the societal and economic conditions in their area of responsibility. To react they conclude that vulnerabilities, potentially resulting from climate change, have to be identified and suitable measures to mitigate negative consequences have to be implemented. Flooding, erosion, and storms are current examples of such events that can cause large damages locally.

Based on a pilot project, during which a local climate change adaptation strategy has been developed and specific measures have been defined and implemented, an evaluation and an audit proved the necessity of an interdisciplinary, cross-sector approach to achieve sustainable climate change adaptation measures on a local level.

Climate change adaptation requires very often decisions about measures that do not concern only one sector, or field of knowledge. Most problems are multi-dimensional, and require the contextual knowledge, as well as practical skills of different actors. The actors, however, come from science and from practice, e. g. administrational departments, organizations, or companies. Even citizens should be included if measures are about to be implemented. Therefore, a cross-sector approach aiming at finding solutions that are harmonized between actors, is indispensable (Heilmann and Pundt 2017). During the evaluation and audit of the pilot project, it has been discovered that the methodological process which has been applied during the project "Klimpass-Aktiv" was successful. Apart from meetings and workshops, the development of a web-based information platform, including an interactive, GIS-supported mapping system and a discussion forum, played an essential role in carrying out an interdisciplinary project that follows a comprehensive, holistic approach in decision making. The online technologies mentioned before can support the participation and teamwork of different actors significantly. This refers not only to scientific cooperation, as stated by Iosifescu and Hurni (2010, p 63): "A GIS platform can support the multidisciplinary research efforts by offering functionalities for intuitive and on-demand access to the necessary research data". In the "BebeR" project, apart from the scientific aspects, the 3rd mission challenge gets high significance: sharing data and expertise between different stakeholders, researchers as well as practitioners, and citizens widens the scope to make sustainable decisions enormously.

5 Conclusions and Outlook

The project BebeR is running a year now and several goals that have been proposed seem to be achievable in time. Setting up a collaborative environment in which several actors from different sectors has been a challenge, but the results achieved so far propose that the willingness to find compromises aiming at finding sustainable climate change adaptation measures clearly exists. However, if different opinions about potential problem solutions occur, it is important to have a moderating, independent institution that provides methodological means to overcome barriers. Thomas and Kilman (2018) propose measures to help actors in a diverse project environment to search for and find compromises. This was, is and will be a major challenge during the next two years.

An overall conclusion is that the evaluation of the pilot project indicates the operational reliability of the proposed methods and processes. Other regions and administrations can use the guidelines and methodologies developed so far, thus indicating that the project has led to innovative and transferable procedures which are potentially eligible to become good practice.

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