EXPERIENCES FROM TESTING MAP VISUALIZATIONS IN A DEVELOPING COUNTRY AS THE BASIS FOR A RESEARCH FRAMEWORK

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Abstract
In order to help sustainably communicate the need and chance of conserving Kakamega Forest (western Kenya) and its unique biodiversity to the local people, stakeholders, decision makers and politicians, visualizations are considered of particular importance in the context of information policy. The paper shortly introduces (interactive) visualizations as derived within the BIOTA East Africa project and how they were tested for their communication to different user groups within a developing country. The testing can be considered a pre-test only, revealing challenges and potentials. Therefore, the framework for a more systematic study is introduced.

1. The setting: biodiversity research in Eastern Africa

Within the research project BIOTA-East (see www.biota-africa.de), funded by the German Federal Ministry of Education and Research (BMBF) since 2001, changes in the biodiversity of Eastern African rainforests caused by land use and environmental changes are investigated. The interdisciplinary research framework encompasses not only biologists and ecologists but also scientists from the socio-economic fields as well as experts in geodata processing. This allows for an integrative analysis of the many field data, their extrapolation in space and time, and the inference of recommendations for conservation and sustainable use of the forests and their biological diversity. The focus area of research of the BIOTA-East project framework is Kakamega Forest in western Kenya (for a detailed description see Mitchell, et al., 2009). In particular for this forest, recommendations for a sustainable biodiversity management at the landscape level and exit strategies to enable the counterparts in Eastern Africa to independently continue the work from mid 2010 have been promised. In this regard capacity building is the major contribution to the anticipated success in the long-term.

In the current third and last project phase the major goal of subproject E02 is no longer the geodata processing (see Schaab et al., 2009; Schaab, 2008). We are now concentrating on simulations by spatially extrapolating BIOTA-East field findings from the forested areas or on scenarios for the surrounding farmland. In addition we are actively involved in management planning to ensure that the diverse spatial information is of use on the ground. GIS-based tools are developed that facilitate the working with

spatial data also for non-GIS-experts. And finally, we consider visualizations of particular importance in the context of information policy, i.e. in order for the BIOTA-East results and concluded recommendations to be communicated to and made understood by the local people, stakeholders, decision makers and politicians. Here, conservation and management of the forest requires the treatment of the people as integral parts of the ecosystem (cp. Meffe, et al., 2006).

2. Maps and geospatial information: the situation in a developing country

According to Goodchild (Baumann, 2008, p.47) 'geospatial data and tools are essential in almost everything we do as humans'. However, they have become accessible only to everyone on the 'well-endowed side of the digital divide'. Also Dorling & Fairbairn (1997) see mapping (the mental process) and map-making (the physical process) as fundamental human activities. The 'mapping ability […] seems innate in every culture' (p.9), or, as Edsall (2007) puts it, the abstract reasoning (encompassing scale, planar view, selection, symbolization) is invariant of culture. A fact, the community-based mapping (CBM) method relies heavily upon (ESSC, 1998). How people perceive reality is influenced by their cognitive abilities, experience, knowledge, and culture (Kirschenbauer, 2004). Here, humans develop their spatial knowledge along stages, starting with land mark knowledge, followed by routing knowledge (connecting objects or land marks), and finally environment or overview knowledge, which can be gained from the observer perspective or via the study of maps. Thus, maps influence people's conception of space (Kraak & Ormeling, 2003; Schultz, 2006) and mapping is therefore related to different conceptualizations (Dorling & Fairbairn, 1997). But what if maps and geospatial information are largely lacking?

In his book 'The innocent Anthropologist' Nigel Barley (2001) tells about his difficulties with the Dowayo tribe of north Cameroon not being able to recognize animals on photographs which he had thought of being useful when trying to clarify their local names. This he identifies as an indication that 'reading' photographs needs to be learned. Regarding map reading there is an on-going debate as to whether it is a natural ability or the result of years-long use of and teaching by maps. However, concensus exists that young children can deal with map-like representations much better than traditionally thought (Montello, 1998). A recent German study on map reading competence confirmed that the school is the place where children will discover their interest in maps (Herzig, et al., 2007). From a historical perspective (cp. Dorling & Fairbairn, 1997), the spread of mapping into people's lives started when farmland had to be measured and enclosed. At school maps are presented not only for educational purposes but to create a sense of identity with the home country. These seem to be indeed the situations when people in western Kenya, if ever, have been exposed to (real) maps.

3. Our visualizations: a basis for testing their usefulness

In order for BIOTA's scientific results and recommendations to become known and adopted on site, a skilful, locally adjusted information transfer is needed. First visualizations heading for this aim and addressing distinct population groups were set-up by making use of the numerous geodata compiled and prepared over the last 8 years.

From the research point of view *thematic maps* for the presentation of scientific results became the first means for visualizing project outcomes. With the former main interest in land cover change and forest use history, results have been either published in map series or in a single map based on a cluster analysis for a synoptic view (e.g. Lung, 2004). Soon it became obvious that a printed text on the forest use history would never allow for the inclusion of figures which consider all the ca. 130 geodatasets the study is based on. Therefore, a *tool for an integrated text and geodata study* was developed supporting the viewing of the diverse map and image information while reading the scientific text. Besides this, a quality diagram provides a detailed but easy-to-grasp judgement of each geodataset. As such the tool not only documents important research results but communicates them in a traceable manner.

Other visualizations introduced here claim to build bridges for people who are not necessarily used to reading maps. *GIS-applications linking amateur photographs and satellite imagery* aim at combining familiar views (photos taken during a flight across the forest) with more exotic ones (a Landsat satellite image of the forest). The clicking on hotlinks placed along the flight path allows to select photographs whose extent is marked on the satellite image and thus makes a direct comparison possible while the application as a whole offers the often missing overview for the people working on the ground. Our *virtual flights* follow the same idea, however, here the photographs have been 'distorted' in such a way that when fading in they match the virtual scenery as created by draping satellite imagery over a digital elevation model. The comparison effect is exaggerated by displaying the satellite image as a false colour composite. The main motivation for interactively manouverable virtual flights has been to inform on the forest state. For deriving *interactive village maps* use was made of the CBM results with very high resolution satellite imagery employed for correctly placing the features. Via a focal mask two information layers can be viewed at a time, e.g. the abstract map and the close-to-reality depiction, i.e. the satellite image. Incorperated photographs or film clips are intended to help overcome the discrepancy between normal perception and the view from above. *Historical narratives* are considered to have good potential in environmental education by stimulating local pride via memory evocation. One narrative employs our land cover change timeseries over the last almost 100 years and allows e.g. a district development officer to generate animations for a particular area of forest to underpin a story of forest change in the area. The other narrative relates to a particular village and is based on specific information from disparate sources.

The *multimedia presentation on BIOTA-East* aims at attracting attention by informing via playful means and in an entertaining manner. The navigation has designated different sections to be visited by adults and children. While the adults can learn about the many subprojects each, children can enjoy the 'Xtras' with e.g. a game on guessing noises from East African rainforests. To both user groups a geodata section is provided. In particular efforts have been put into the diversity of interaction types and effects, consistent user guidance as well as appealing graphics. Embedded in the multimedia presentation is a *game on local forest use*. When correctly dragging and dropping 23 photographs of identified forest uses on either of two backboards, named 'forbidden' and 'permitted in parts', a map reveals in which part of the forest the rules apply. However, the game was based on incomplete information only. While the game shows potential also in environmental education, the multimedia presentation is intended to raise interest in biodiversity research. For a more detailed description of all the interactive visualizations including meaningful screenshots see Schaab, et al. (in press).

4. The testing: individual interviews

Visualizations being prepared within research projects are often exclusively presented to a scientific audience belonging to a similar field and whose reasoning is familiar to the mediator. The requirement of the BIOTA visualizations to reach different user groups of a different culture and from a developing country, led to the idea to test selected BIOTA-East visualizations in Kenya in autumn 2007. The *aims* can be summarized as following:

- To find out about how Kenyans mentally process information in a spatial context (referring here to mental maps).
- To make experiences in teaching map / satellite image reading (literacy), a) in a foreign culture and b) with the help of modern techniques.
- To get hints on best means of communication for BIOTA-East's spatial data and information (do new techniques enhance understanding? Which new techniques best serve specific purposes?).
- To find out about the stimulating potential of geospatial data visualization for raising interest in the forest itself.

Within the study four different *tests* considering five visualizations were performed by means of semi-structered interviews:

1. interactive village maps in combination with a GPS-equipped PDA (Personal Digital Assistant): test emphasizing on map reading skills (n = 11, local people),
2. local forest use game: with the side effect of also learning about restrictions and opinions (n = 14, locals and forest guards/rangers),
3. thematic maps (map series vs. synoptic map) plus virtual flight: comparing different means of spatial data depiction (n = 2, multiplicators / decision makers),

4. virtual flight vs. GIS application: looking into possible working tools (n = 4, scientists to whom Kakamega Forest is known).

The age of the people interviewed ranged from 14 to 73 years, with two thirds of them being male. Educational background reached from none at all up to PhD with a majority (7 + 9) having followed education as far as primary or secondary school (but not necessarily finished it). In 7 cases a translation into/from Luyha was required during the interviews. 14 people interviewed regarding test 1 and 2 were born in the village in which the interview took place, and the 6 guards/rangers stated to live 'in the forest'. Most of the locals interviewed (11) described their profession as being farmers, among them 3 volunteering for KEEP (an environmental education CBO), 2 were pupils, 1 a teacher and 1 a pastor.

Apart from test 1 all other started with questions on the interviewee's knowledge of the forest or forest use regulations. All semi-structured interviews included as a first task the drawing of a mental map of either Kakamega Forest or the route taken from the person's home to the meeting point. After having been asked to explain what they have drawn, also the questions 'How do you keep orientation when walking?' and 'How do you orient yourself in a foreign place?' followed. In the case of the interactive village maps, the interviewee was then asked to make use of the tool while at the same time commenting. Here, the person was carefully observed concerning what had been recognized, his/her interactions and the length of remaining interested. Afterwards the villager was introduced to similar information but stored on a PDA. During a short walk in the village explanation were given on the own moving position in relation to the map or satellite image as well as what features can be seen in a map as compared to very high resolution satellite imagery. Back at the meeting point, again the interactive village map was activated and again the user observed regarding handling and use. In case of the 'drag & drop' game on local forest use a first hint of the local's or ranger's knowledge on the forest use regulations was asked for in context with his/her mental map of Kakamega Forest. Next, the functioning of the game was explained before then observing the addressee's actions and comments. In particular of interest was if the person would make use of the map displayed. We also learned if he/she agreed with the classification into 'forbidden' or 'permitted in parts' as well as the regulations behind partial permissions. In the case of comparing thematic maps and a virtual flight, the person interviewed was told to first learn about land cover change by studying maps. Whether this worked was tested by asking specific questions ending with whether he/she would believe in the maps shown. Next, the person was asked to make use of a virtual flight again accompanied by observations and it was of interest, if the person would make use of the maps at the same time. The interview ended with questions to find out about which of the two modes of presentation is more convincing and why, and if the photographs helped in believing what had been presented to the multiplicator or decision maker. In test 4 after the question relating to familiarity with the forest and the task of drawing a map, the scientist had to show on a Landsat satellite printout the locations of well-known places in and around Kakamega Forest. Next, the same features

had to be traced in the virtual flight. The person was observed in their use of the interaction possibilities. Finally, he/she was asked to also look for the same features in the interactive GIS application. Here observations were used to find out if the candidate would also check for things of his/her own personal interest. At last we wanted to find out which of the modes of presentation was preferred including reasons and for what they, the scientists, would like to make use of them.

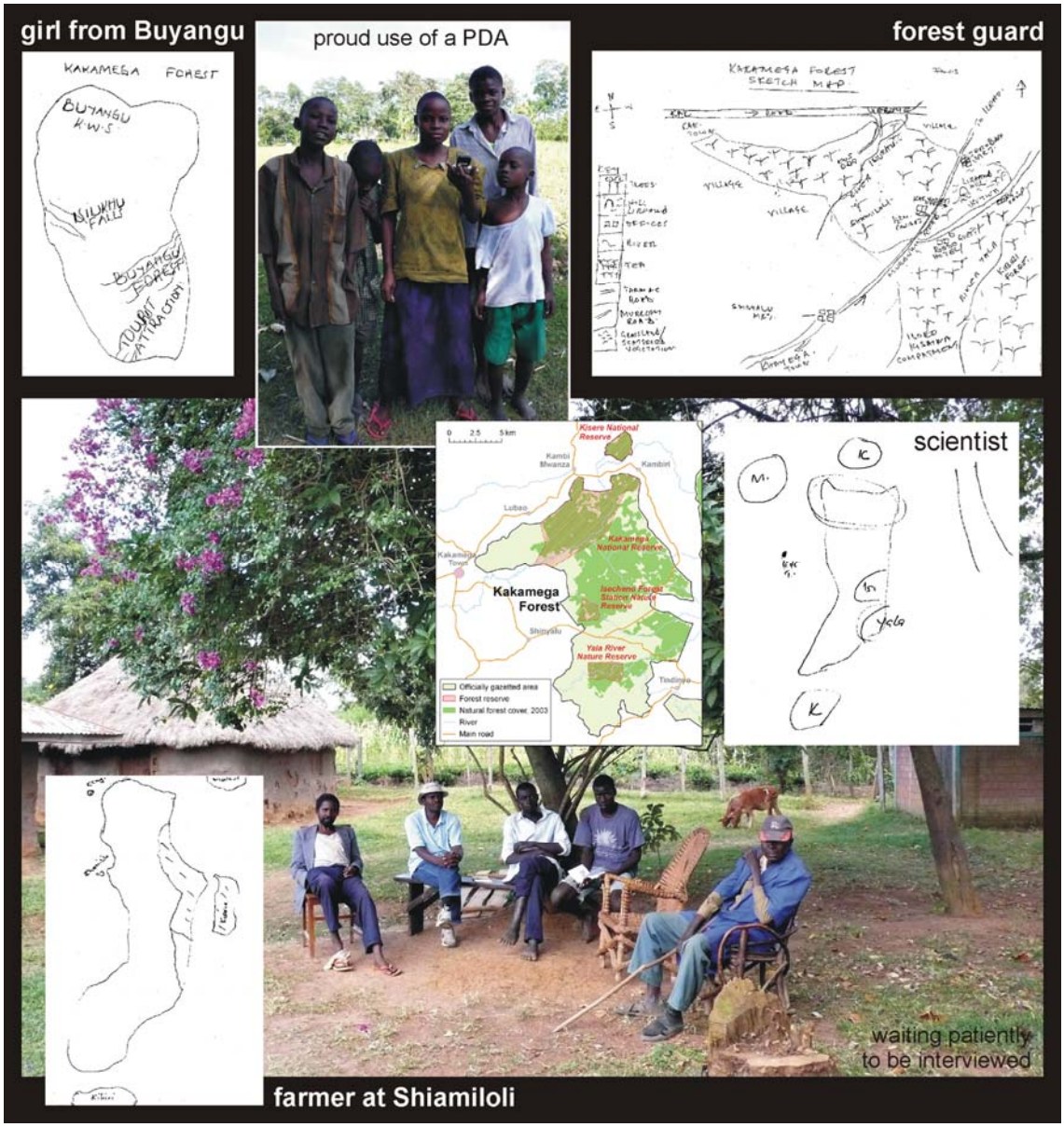

Figure 1: Photographic impressions from the interviews undertaken in western Kenya together with examples of mental map depictions for Kakamega Forest.

5. Preliminary results: challenges and potentials

All candidates, either local people, forest guards/rangers, decision makers / multiplicators, or scientists, were very keen to take part in the interviews. Figure 1 provides some impressions from people patiently waiting for their turn or being proud candidates. Besides selected mental maps for Kakamega Forest are shown revealing a very wide range of possible depictions.

The analysis of the observations made during the interviews regarding mental maps, orientation means, familiarity with maps or map / satellite imagery reading as well as regarding the suitability of modern interactive and/or animated forms of information transfer of the in total 31 test persons provides us with a list of surprises. The following *challenges*, not necessarily to be expected, are faced when going for such interviews in Kenya:

- It is not the rule that at school people will be introduced to maps.
- Almost all people never educated at school refuse to take a pencil in their hand.
- Drawing of a mental map might take seconds or almost hours.
- People never having touched a computer get soon very tired (stop too early) while those with some experience do not want to stop.
- A film clip aiming to provide a familiar view (incorporated into one of the interactive village maps) is more distracting (‘Like TV!’) than helpful.
- Many local people have bad eyesight.
- Interviews with people never having been to school and with bad eyesight are hardly possible.
- It is likely that more people than planned will show up for being interviewed.
- Translations given by local field assistants might be much shorter or much longer than the Luyha version.

Points that have been *ascertained* are:

- Kenyan people have a very good spatial orientation but do not make use of a mental map.
- Their having come into contact with maps and spatial data (e.g. satellite imagery) does not have a great influence on their spatial orientation processing.
- Not only the locals but also the people in charge of forest management in Kakamega Forest do not know all the restrictions of local forest use.

Finally, the major *potentials* can be summarized as follows:

- The availability of spatial depictions is still rather limited to the Kenyan population. However, depictions of their forest and its history seem to be a promising medium for stimulating local pride and a closer relationship to the environment being in need for protection.

- PDAs, hand-held computers with an integrated GPS (Global Position System), are ideal tools for helping beginners to understand map reading, this by incorporating very-high-resolution satellite imagery.
- Playful material is awarded a very high potential in environmental education of the local people but also for training the forest guards/rangers. Besides software products, it is necessary to still consider printed products.
- Educated Kenyans are fascinated by the new possibilities of computer-aided interaction and animation. But only after the individual and intensive occupation with landscape visualizations do they show an adequate interest for spatial data and representations.

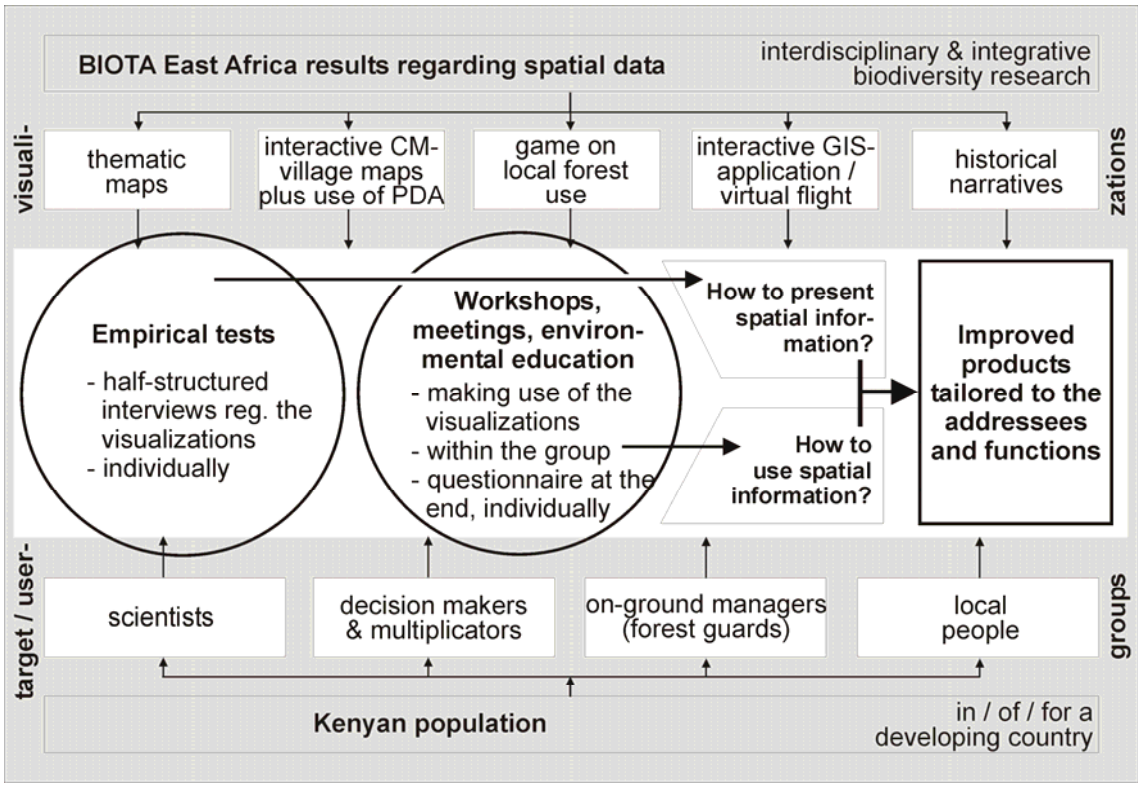

Figure 2: Flowchart on the planned project for a systematic study on how to impart scientific results in a developing country.

6. Outlook: framework for a systematic study

While the described investigations revealed important hints on the effectiveness of our visualisations, i.e. on how information should be presented to excite the people to whom the forest and its biodiversity should matter, we are aware of the current study's limitations. Instead a thorough, systematic study would be needed. The planned project (see figure 2), on the one hand, aims at learning via broadly set-up empirical tests how spatial information should be presented to each target group. Here, the scientific results

have to be adapted to reach the people of a developing country despite its diverse conditions. On the other hand, we also wish to gain experiences at very different occasions on how spatial information is to be used best in order to take the differing needs into account, this accompanied by an assessment. Products tailored for specific users and functions should become the end products of research. These are to help sustainably communicate the need and chance of conserving Kakamega Forest and its unique biodiversity.

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