GEOGRAPHIC INFORMATION SYSTEMS IN DEVELOPING COUNTRIES – WHAT ARE THE ETHICAL ISSUES WE NEED TO BE AWARE OF?

GEOGRAFICKÉ INFORMAČNÍ SYSTÉMY A JEJICH VYUŽITÍ V ROZVOJOVÝCH ZEMÍCH - JAKÝM ETICKÝM OTÁZKÁM MUSÍME ČELIT?

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Abstract

The use of GIS in developing countries has been coined as an oxymoron for several reasons, but mainly due to the fact that the historical burden of maps is to have been used as a tool of control and technological dominance. Participatory approaches in mapping and GIS allow to bring a greater degree of social responsibility and ethics in research and visualisation of local spatial knowledge. The article focuses on the description of selected reasons that led to the sceptical attitude towards GIS, and to identify the basic ethical issues of collection and interpretation of spatial information in developing countries on an example of mapping water resources in the village Koffiekraal in South Africa.

Abstrakt

Využití geografických informačních systémů (GIS) v rozvojových zemích se musí potýkat s historickou skepsí, kterou mapy, jako nástroj moci, mají mezi původními obyvateli. Participativní přístupy v mapování a GIS se snaží přistupovat k místním prostorovým znalostem s větší mírou společenské a etické zodpovědnosti. Článek se soustředí na popis vybraných důvodů, které vedly ke skeptickému postoji vůči GIS, a na identifikaci základních etických otázek sběru a interpretace prostorových informací v rozvojových zemích na příkladu mapování vodních zdrojů ve vesnici Koffiekraal v Jihoafrické republice.

Key words: Participatory GIS, South Africa, water resources, ethics, whose questions

1 INTRODUCTION

Geography has dealt with spatial information since the first references. With the rise of the information technologies (IT) in mid-20th century, geography also started to use features of IT within the science. The first steps of merging spatial information with statistical data can be tracked to the maps of cholera in Paris in 1832 [29] and London in 1854 [53]. The first computer system for merging spatial information with statistical data was the Canadian Geographic Information System (CGIS) made in the 60s and 70s by Roger Tomlinson, also known the "Father of GIS".

1.1 History of mapping and use of GIS in Africa

The first task for Roger Tomlinson was to determine a good location for planting trees to feed a planned paper mill in Kenya. The plantation would have to be on a suitable slope, on appropriate land, in a location affected by the right weather conditions and with access to transportation for workers. Moreover, being in Africa, the location would have to be free of monkeys, which eat young trees; and safely away from elephant migration routes. That meant referring to and manually overlaying data from many different maps or putting maps into a computer to get "a bunch of numbers", while those numbers could be combined with those from other maps to produce complete information. [23]

Since the first CGIS there has been intensive development, which has lately almost become an independent scientific field. GIS like other scientific disciplines faced criticism and skepticism from many quarters. Different phases of the discussion among geographers and social scientists with GIS proponents led to critical evaluation of not just the components of GIS, but also the implications of GIS as a technology.

The critical discussion during the 90s led to the emergence of a new field within classical GIS called Participatory GIS (PGIS[1]). Participatory GIS comes from the fear that GIS, highly used for spatial analyses and spatial decision-making processes, will only strengthen the top-down approach in current development. This fear also comes from the fact that three of four main parts of GIS: hardware, software and data, are very expensive components and still need highly trained GIS operators to operate them. Therefore, GIS is sometimes called an "expert system".

Many critics [1,17] of GIS pointed out that the technology was being employed with the explicit goal of expanding political and economic control over those already disadvantaged by local, regional, and global divisions of power. Therefore, they were afraid that GIS was still only a tool of control and technological surveillance. Obermeyer [39] states that as a tool of technological control, GIS was mainly developed and practiced by white males employed in academic and governmental institutions in North America and Europe.

Participatory GIS is an attempt to bring GIS as a technology closer to the communities who are directly involved in, as well as affected by, development policies and the decision-making processes of various development agencies. PGIS also aims to incorporate local spatial knowledge, often transmitted in oral forms, into the expert and "official" GIS data.

From the beginning of European mapping in Africa, it was clear that the European colonial powers have no unifying idea and methodology as to how should Africa be mapped. Bartholomew [3] states, that out of 29.8 mil. km^2 in Africa, 9.8 mil. km^2 were unmapped and unexplored by Europeans in 1890. Colonial mapping in Africa started long before the Berlin conference in 1884, when the European powers divided their spheres of influence over the African continent. France has performed some very intensive mapping in North Africa since the 1840s and the United Kingdom undertook some limited attempts in South Africa. On the other hand Portugal had already been present in some parts of Africa for centuries, yet made no significant efforts to map their colonies at all [9].

As the colonial history of mapping in Africa was originally based on three main needs – business, administration and war, it was obvious that maps were another tool of control and technological surveillance. Commercial mapping was carried out mainly in German South-West Africa[2] by *Deutsche Kolonialgesellschaft für Südwestafrika* and *Deutsche Diamanten-Gesellschaft*. Great Britain mapped its colonies mainly in order to facilitate the process of administration and tax collection. In the African colonies of Great Britain, the Indian model, which worked well under control of the *Survey of India* (SoI), was used. France used *le Service Géographique de l'Armée* (SGA) and as the name suggests it was mainly military mapping that was conducted by this organization [9,35,36].

The understanding of maps as a tool of colonial rule and technological surveillance was transferred also to the understanding of geographic information systems as a tool of neo-colonialism. It was this fear that first led critics to start the discussion about concepts of GIS as well as ethical aspects of GIS. Critics were afraid that spatial technology represented by GIS would be used to strengthen political and economic control over those already disempowered and disadvantaged by current division of power [41,44].

1.2 Critics of GIS

With the rise of the GIS the discussion about the representation of the reality on maps transferred into the discussion about the digital spatial information and especially related to the representation, visualization and use of various digital cartographic outputs. The *Scramble for Africa* was already over, but the conceptual discourse about how geography as a discipline should treat the newly growing discipline GIS, just started.

The first phase of the discussion about GIS in the 1990s can be represented mainly by disgust and disapproval towards the new discipline. Taylor [54] in his editorial of *Political Geography Quarterly* speaks about GIS as the imperialistic geography and its proponents he calls members of the Cult of Information who spend most of the time searching problems, that can be solved by their tools.

There was only limited discussion about ethical questions related to GIS when GIS was considered only a tool for physical geography, but it became more intensive with increased interests from social scientists and human geographers. The discussion was steered toward the impact of GIS as such and it was motivated mainly by the aspirations of different fraction groups within the geography to direct the discipline into a certain direction [45,49].

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[1]   Variously labelled as Public Participation GIS, Bottom-Up GIS, Community GIS, etc.
[2]   Since 1990 we know this country as Namibia

Taylor [54] believes that GIS should be called GKS (Geographic Knowledge System), because information is just a collection of data without direct meaning, and only the interpretation of this data creates content and therefore combines measurements with data and ideas into messages with evaluation. This idea follows the discussion that scientific disciplines are formed by knowledge they produce and not just by facts they describe. Taylor [54] is also afraid that geography is going back to the description of the world through GIS instead of developing it further. The first phase of criticism of GIS is also linked with works of Clark [8] and Pickles [44].

Critics usually expressed their concerns in socio-theoretical terms, far from the technological language of their opponents and this made their opponents´ situation even harder. The philosophical education of GIS opponents in most cases ended with Karl Popper and Thomas Kuhn. The language barriers between these two groups seemed to be much greater than their ideological differences [40,49].

The socio-economic benefits of GIS have been criticized by different scholars for under-representing the people excluded from society [24,48], for the social implications of GIS as a technology [44,52], for increasing the surveillance upon the society [14,22], for being a black-box technology [14,22] and for being just a profit motivated technology [57]. In 2000 Nadine Schuurmann [50] introduced the term Critical GIS and her discussion shed new light on the ways in which PGIS can have further impact on the exploitation of local spatial knowledge. Schuurmann described three waves of critics of GIS in her publication *Trouble in the heartland: GIS and its critics in the 1990s*.

The author of this paper acknowledges that there is continuous development in the understanding of GIS and he takes the fourth wave of criticism of GIS as the discussion about the intensive use of GIS in fields neglected so far. Participatory GIS became quite popular after making some thematic books [11] and special editions of journals focused on participatory approaches in GIS available (Cartography and Geographic Information Systems 1998; Cartographica 2001; Environment and Planning B 2001; Journal of the Urban and Regional Information Systems Association 2003, URISA Journal 2012) as well as conferences such as URISA Annual Public Participation GIS Conference or Mapping for Change[3].

According to Dunn [17] PGIS was also used in brand new areas of geographical research such as urban planning and public participation [7,10,18,19,21], land ownership and resource management conflict solutions [25,26,30,31,60,61], First Nations[4] access to land and services [5,32], protection of the environment [33,51,55] or land-use and natural resources management [56,59]. In the last decade, a number of books critically discussed the role of maps and information transmitted by maps [16,62,63] as well as the role of GIS in the process of creating these maps [12,38] and about the relationship between GIS and society [20,37]. The amount of books focused on GIS and its position towards society or GIS and the ethical question this technology brings is nevertheless insufficient. This trend is visible in the top ten best-selling books about GIS on Amazon.com [2] where only one book has a chapter about ethics of GIS and the relationship between GIS and society.

2 MAPPING THE WATER RESOURCES IN KOFFIEKRAAL

During the operation of the project *Roots Driven Rural Development* (RDRD [42]), implemented in the Koffiekraal village in the North-West Province of South Africa, one of the aims was to map current communal water-points and suggest an ideal spot for a new water-point. The maps used for the analysis came from the process of participatory mapping in Koffiekraal [58]. The Water supply and sanitation policy [15] guideline states that households should not travel more than 200 metres to fetch water. It is claimed in a report by the Port Elizabeth local government that more than 90 per cent of South Africans have access to water within 200 metres of their homes [28].

The GIS water-provision analysis was completed in ArcGIS 10.1 using the data captured during the Participatory mapping process in Koffiekraal. Based on the previous research in the Koffiekraal village [58] 66 communal water-points were mapped and uploaded to the OpenStreetMap. Besides the water-points, 68 private houses with boreholes were identified and taken into account while processing the GIS analysis. In order to create the proper network analysis, 1174 road elements were created and digitalised based on the aerial photography of the area provided by the Chief Directorate: National Geo-spatial Information, the national mapping agency of South Africa.

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[3]   International Conference on Participatory Spatial Information Management and Communication, Nairobi, Kenya, 7th–10th September 2005
[4]   The politically correct term for indigenous or native populations, mainly used in Canada.

The two shapefiles – communal water-points (points) and roads (lines) were used to create the network dataset by using the Network Analyst extension of the ArcGIS 10.1. In order to create a clean topology of digitised roads, the authors used the *Planarize Lines* tool from the Advanced Editing Toolbox. As a result of this analysis, 66 Service Area polygons were created with a 200-metre break value and not-overlapping multiple facilities polygons, i.e. the polygons were allocated to the closest facility (Fig. 1). They created also a buffer of 200 metres around each water-point just to show the difference between the Euclidian distance (buffer) and the network analysis service area. The following analysis showed that there are 749 households (65% of Koffiekraal) lying within the 200-metre service area from at least one communal water-point. This number is much lower than the 1015 households (88% of Koffiekraal) identified through the buffer analysis. From the results one can derive that 35 % of households in Koffiekraal (estimated to 3500 inhabitants) live more than 200 metres from the closest water-point.

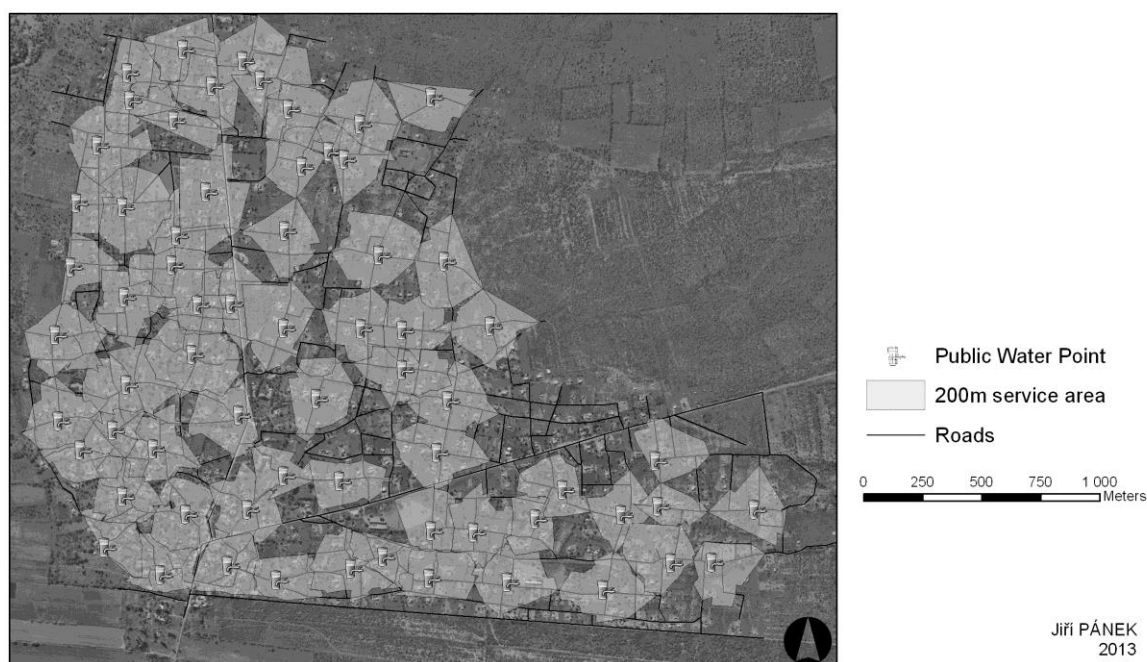**Two hundred metres Service Areas of public water points in Koffiekraal (2013)**

Fig. 1 Two hundred metre Service Areas polygons in Koffiekraal

Although it is a very elementary analysis from the technological point of view, it has a great impact on the Koffiekraal population. Before publishing these results, in spite of being generalised and in some concern also very simplistic, the general public had no information about the spatial distribution of communal water points and it was up to the will of local leaders and elites where and how new water points should be established. The general public was not involved in the decision-making process in any other way.

Maps were historically used for administration of cities, states and nations as well as colonial projects and war operations [46]. People are used to create maps, but until recently only in limited cases as their authors [43]. Nevertheless, it is obvious that people are able to produce their own maps. In the last three decades with the democratisation of cartography [47] and the democratisation of GIS [6], people have started to use maps and GIS in more participatory ways than ever before. With the democratisation of these two main streams, a new approach to cartography is becoming more visible – critical cartography [12,13]. The process of empowerment historically represented by the electrification and more recently the informatisation of society is now achievable through maps, which gives disadvantaged groups within society a claim to what is rightfully theirs.

3 ETHICAL QUESTIONS RELATED TO THE WORK WITH SPATIAL INFORMATION

At the end of the 1990s, first glimpses of identifying ethical questions related to the use and work with spatial information in developing countries appeared. Most of these questions should be asked before the process even starts [1,27]. These questions are sometimes generally called „Who and Whose Questions" and they serve to ensure the basic ethical regulations in conducting spatial research in communities and working with the local/indigenous spatial knowledge (ISK/LSK).

Who and Whose Questions were defined as follows:

- Who participates in whose mapping?

- Whose knowledge, categories, perceptions and reality are expressed?

- What is missing (e.g. micro environments like home gardens)?

- Who owns the map?

- Where is it kept?

- Who has access and why?

- Who understands it?

- Who updates it?

- Who uses it?

- For what purposes?

- Who is empowered and who disempowered?

- Who gains and who loses? [27]

This is definitely not the final list of questions, but rather the initial guidelines. In different versions, one can find a question related to the legend of the map, the process of mapping, what and who should be mapped or what and who should be excluded and why?

The main ethical question related to the Koffiekraal research is with whom shall we share our findings and how? Currently there is a publicly available layer of water resources on the OpenStreetMap (Fig. 2 and 3), but for instance the layer of houses with private boreholes is not publicly available anywhere.
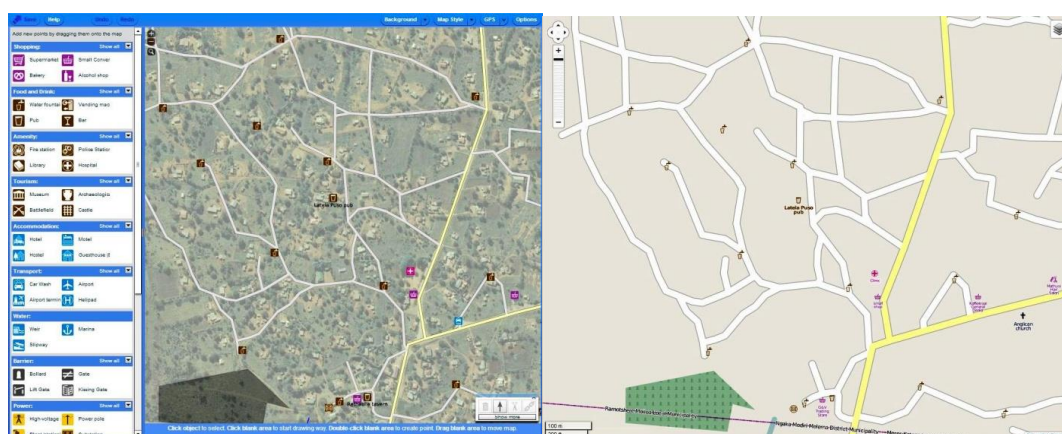

Fig. 2 and 3 The accessibility of public water sources in Koffiekraal – the editing and the view mode of the OpenStreetMap

The general question of most participatory mapping projects is „*Who participates in whose mapping*?". In case of the Koffiekraal project, the mapping was conducted by the members of the Department of Geography at the University of South Africa (UNISA) together with development workers from the local non-profit organisation Greater Rustenburg Community Foundation (GRCF). This biggest challenge according to Chambers [28] is to realise the fact that „*They can do it!*", where "they" mean the members of the community. Obermeyer [39] states that GIS as a tool of technological control was mainly

developed and practised by *white males employed in academic and governmental institutions in North America and Europe* and Taylor [54] talks about GISers as people who *spend much of their time searching for problems for which they have the means to find solutions* and he is afraid of that *merging of this technology-led mentality with the propensity of geography to study anything that is 'spatial' (i.e. everything) produces the imperialism of the new geography*. In participatory mapping or a participatory GIS process, the main task of the GIS experts is to hand over the stick and just be there in case of need. Do not disturb the process with your ideas!

Another key questions that should be answered are „*Who owns the map?*", „*Where is it kept?*" and „*Who has access and why?*". These questions complicate the current state of the art as the Koffiekraal map has several versions. There is an electronic version available online on the OpenStreetMap, which includes only information about water points, but not the results of the analysis. These data are freely accessible and theoretically without a single owner. There is also a Quantum GIS project with all data collected, including the private houses with boreholes, saved in shapefiles. These data were handed over to the community, but another questions were raised „*Who understands it?*" a „*Who updates it?*". At the end of the mapping community received CDs containing the Quantum GIS, the layers already captured and a manual specially developed for getting started with using QGIS for community mapping in Koffiekraal. One can always continue asking more questions related to the usability and ethics of the specific research as well as economic and technical questions related to sustainability.

4 DISCUSSION AND CONCLUSIONS

The main aim of the article is not to describe new geoinformatics methods of new applications of unique research merely to allow the current generation of GIS users, who did not experience the critical discussion about the social implications of GIS, to stop in this hectic time and ask a simple question related to their research - „*Who gains and who loses?*".

Geographic information systems have become one of the fundamental tools in geographical research and in last decades they have also become an important tool in social and development research and projects. The question of basic ethics related to the work with spatial data must be the cornerstone of every work in developing countries.

If we come back to the question „*Who gains and who loses?*", we can always apply it to the reality of development projects. We can ask, why does Google inc. show the area of *Arunachal Pradesh* on its maps as part of India or China or the disputed area depending on viewers IP addresses [41]? We can also ask the Monmonier's question *"How to lie with maps?"* [34]. All these questions should lead the GIS user to realise his/her role in the whole process of collection, creation, analysis and interpretation of spatial data. In current time of mash-ups and crowdsourcing, the very same data are really the tools of technological dominance in hands of those who know how to use them.

The project of mapping water resources in Koffiekraal can serve as a model to realise how many questions one should ask, while conducting a GIS project.

5 ACKNOWLEDGEMENT

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RESUMÉ

Článek se zabývá základními etickými otázkami, které mohou nastat při práci s prostorovými daty nejen v rozvojových zemích. Autor pracuje s případovou studií mapování vodních zdrojů ve vesnici Koffiekraal v Severozápadní provincii Jihoafrické republice. Hlavním cílem tohoto článku není popis nové geoinformatické metody či aplikace unikátního výzkumu v praxi. Cílem je umožnit současné generaci GIS uživatelů, kteří aktivně nezažili kritickou diskuzi ohledně GIS v 90. letech 20. století, možnost zastavit se a poskytnout prostor k diskuzi nad základní otázkou využití GIS – „Who gains and who loses?". Mapování vodních zdrojů ve vesnici Koffiekraal může sloužit jako ukázka, kolik různých otázek si GIS operátor musí položit, než vůbec začne mapovat, aby věděl, co a pro koho mapuje, jak se s výstupem jeho práce bude nakládat a také komu tím prospěje.