Briefing Note no. 2, April 2007

Social Geographic Information Systems (SGIS): Integrating GIS and participatory mapping

Lars Soeftestad
Supras Consult Ltd [1/]

Background

This note addresses Supras' approach to working with Geographic Information Systems (GIS), specifically how to integrate GIS in its participatory approach to project design and project implementation. This approach is called Social Geographic Information Systems (SGIS). A bibliography of relevant knowledge, including CD-ROMs, literature, videos, and websites, is available on the Supras website.[2/]

The note was written as background for a paper titled "Environmental trends analysis (ETA): Tools for poverty alleviation", to be presented at the ESRI UC conference in San Diego, California, USA, in June 2007.

1. Introduction

The purpose of this note is to focus attention on: (1) Key problems connected with the way in which GIS are being applied to cultures and social phenomena globally with often little regard for their unique qualities and needs and (2) How best to address these problems. This will involve arguments on theoretical and practical / methodological levels as well as the interactions between these levels.[3/]

At the global level two major processes are unfolding: One the one hand there is what in somewhat general terms is referred to as *globalization*. On the other hand there is the increasing focus on the local level, occurring both in the North and the South, but for different reasons and with different goals, which here will be labeled as *decentralization*. Globalization results in the exclusion and marginalization of diverse categories of stakeholders at the local level in developing countries, while decentralization leads to integration and participation of some of these stakeholders.

These two intertwined processes represent the broad unfolding canvas against which we have to understand and assess the present growing use of GIS, in general but specifically as applied to more or less exotic and/or marginal cultures (as understood from the point of view of the West). There are three separate but closely connected aspects to consider: (1) Technology, (2) Communication and

[1/] CEO, Supras Consult Ltd (Norway, UK and Bulgaria) at www.supras.biz. Email: lars@supras.biz.

[2/] URL: www.supras.biz/knowledge/gis/socialgis.html.

[3/] The note draws upon a number of papers and publications, my own as well as those of others. As its nature or form is more like a concept note, detailed references have, at this point, not been incorporate. Instead, I refer the interested reader to the bibliography pertaining to SGIS that was prepared in connection with writing this paper (see Footnote 2 for URL).

(3) Knowledge. Each aspect needs to be considered apart from the other two, including how they interact with each other, with a specific focus on synergies.

Each of these three aspects are causally related to the other two in complex ways. And, in the same way that cultures differ from each other, the way in which these three elements are understood, defined, and related within a particular culture are, in a cross-cultural perspective, largely unique, and cannot be taken a priori as given.

1.1 Technology

Technology, specifically advanced Western technology, plays a key role in how globalization and decentralization is being conceptualized and implemented, as it were. Information and Communication Technologies (ICTs) is the single technology that plays a determinate role in advancing the globalization and decentralization processes, and in this paper ICTs are understood to include GIS. Conversely, globalization and, to a less extent decentralization, have contributed in a major way to developing and expanding ICTs. How this has played out at the local and receiving end is hotly debated. A lot of the available evidence seems to point to increased availability of ICTs, but that access is limited partly for technological and economic reasons, and partly for socio-cultural reasons. At the local level in many developing countries ICTs have not contributed noticeably in areas like empowerment, specifically for women, participation, equity, and reduction of poverty.

The specific technology in question here consists, of course, of software and the computer systems that it is used in conjunction with. This is, however, a limited understanding of what the relevant technology includes or involves. This particular technology – as indeed all technology – has evolved within the context of a societal culture and structure, and is an expression of as well as an extension of this culture and structure. While it is correct to say that the software and the hardware is integrated, it should be added that this integration has come about within a specific societal structure at a particular point in its evolution, and that both these parts have evolved – and are continuing to evolve – within this structure.

Following fairly accepted mainstream usage, GIS will here initially be understood in a narrow sense as a computer system-based utilization of geographically referenced information. The emphasis is largely on how such geographically referenced information is being fed into the combined software-hardware system for purposes of analysis, description, classification, and production of maps, etc. Two points should be noted here: (1) The nature of this "geographically referenced information" is not necessarily problematized and is often taken for granted and (2) The methodology for collecting this information, including who is responsible for defining and identifying the information to be collected, as well as who is responsible for actual data collection, is seldom focused upon.

The use of GIS is growing fast. The number of applications in new areas of concern is increasing, as are the specific adaptations within these areas.

The essence of GIS is that it was created as a technology and a technique. And, any efforts to argue the contrary notwithstanding, it is still nothing but a technology and a technique. As a fully developed (but at the same time still evolving) and integrated technology, in the interaction between the technology and the ever-increasing areas where it is being deployed and employed, an essential aspect of this interaction is that it is the receiving end that has to adapt and modify. The larger the difference, the more adaptation is necessary. In other words, the interaction between the technology and the areas to which it is being employed is essentially not really an equal interaction.

This invokes the familiar issue of technology as a means and as a goal. GIS is a good example of technology as a goal, more specifically, technology as a goal in itself. However, the situation is more complex than that. On the one hand are the providers and users that, from their respective limited situation and rationale clearly view it as a means. For providers of GIS products they are a means to make a profit, while the users see such products as a means to achieve specific goals. On the other hand there is the system or structure, that is, what partly includes the so-called “global spatial data infrastructure” (to borrow the term coined by the Global Spatial Data Infrastructure Association),[4/] the abstract non-descript level that all GIS stakeholders are part of in various ways. This structure tends to identify GIS automatically and implicitly as a goal in itself. To look for a rationale for this is not, well, rational, as it has not come about by rational decisions of any constituting elements, that is, individual members of the structure. As for the processes by which this happens, it can possibly be referred to as the approach of least resistance. The structure reduces content to acceptable and manageable levels, and technology in general – here represented by GIS – is assessed, viewed, and utilized in increasingly instrumental ways, and becomes a goal in itself. The number of GIS software units sold, number of GIS applications, etc., becomes the norm and the measuring rod (much like, say, how the number of cell phones per capita is considered an indicator of development). This transformation is necessary in order to operationalize use of GIS at the macro-level and construct indicators. And this process of instrumentalization and objectivization is part and parcel (goes along with) of (arriving at) transforming GIS into a goal in itself. What we have here, then, is a dichotomy between the structure and its constituting elements, and between the macro- and the micro-levels.

1.2 Communication

Communication as understood here is, essentially and at its most fundamental level, a relationship *between people*. Originally or traditionally direct, communication typically took place between individuals. The content is complex, rich and many-layered. Modern communication is also complex, but in different ways. It takes place between many more stakeholders, which often are located at different levels. The number of arenas has multiplied. The medium of communication is more and more written, and increasingly in electronic form. Modern-day communication is often asymmetrical in one way or another, the content is often instrumental, and it increasingly contains data without a contextual frame of reference.[5/]

All of this leads to, causes, and reinforces a situation where the technology, including GIS software, becomes not optimally suited to address the specificity of the realities that it is being applied to, especially as available or identified at the local level. This is not so much because of anything inherent in the technology itself, but rather because the technology comes packaged in this larger structure that, *en passant*, is Western, largely American. In fact, the technology can be understood to be in large measure a product of and a reflection of this structure.

This invokes the large field of communication across cultures, languages, and economic and political systems, which in this context are labeled as *development communication*. Human communication can be analyzed of in terms of these two models:

1. *Interactive model*. Communication moves back and forth between the source and the receiver. Both parties to the exchange takes on simultaneous roles of receiver and sender, and
2. *Linear model*. Communication is a unidirectional event that moves in a straight line from the source to the receiver.

The relationship between the participants to communication in both models can be equal or unequal. The big difference between them becomes apparent when analyzing communication that is based on

---

[4/] URL: www.gsdi.org.

[5/] Cf. Soeftestad, Lars T. 2001. Aligning needs and means: On culture, ICT and knowledge in development cooperation. Proceedings of the 24th Information Systems Research Seminar in Scandinavia, Ulvik, Norway, pp. 47-60. URL: www.supras.biz.

use of ICTs, that is, where the parties to the communication are not interacting face-to-face. The introduction of ICTs as the medium and facilitator of communication across all manner of traditional cultural, mental, physical, and social boundaries (incl. continents, cultures, countries, ethnicities, languages, regions, and values) have the effect of upsetting traditional variables that would determine the process of an exchange, including the aspect of equality. Briefly, then, and to caricature it somewhat, when one of the parties to the communication represents the culture, language, and technology, and the other party represents a small, marginalized culture and language, the exchange is bound to be unequal, not the least because the first party will have control over, as it were, the topic as well as the means of communication. This typically ends up in a linear type of communication.

Suffice it to say that, as a result of this impact on communication, this technology thus easily glosses over, and/or does not interact with, lots of facts and complexities in a culture. This is so because it is not equipped to address this, and the technology structure, as it were, supports and facilitates this. These facts and complexities include, *inter alia*, cultures and cultural variation, linguistic differences, value systems, modes of social organization, mores, and the vast variation globally in the differences between Nature and Culture as well as how they interact and relate to each other. This takes place partly when trying to engage with/at the local level, and partly (certainly) in its traditional or most common modus, which is to engage only at the macro level. For, while feeding local-level data into this technological macro-level context, these same complex data will of necessity have to be transformed, limited, reduced, and changed in order to fit. Contextual data disappears in the process or else are left out deliberately. This technology accordingly is suited to deal with data or information, and does not favor knowledge, which is to be discussed next.

1.3 Knowledge

Knowledge is a tricky thing, straightforward and simple yet at the same time very complex. This is so because we all subconsciously tend to associate – even equate – the term “knowledge” with what we hold dear, know to be facts and, moreover, what we know to be correct. In essence, knowledge is part and parcel of culture, it is the accumulated insights and truths of a culture. While this is correct, it also needs to be qualified. Viewed from inside a culture it is of course correct. Viewed from outside the culture it may or may not be correct. In many cases, the larger the difference between two cultures – and their associated knowledge – is, the higher the chance that aspects of one culture will be found to be incorrect or not acceptable as viewed from the other culture. It follows that knowledge is not a universal, but a cultural or societal given. One needs to take on a cultural relativistic perspective in discussing culture, and in recognition of this we should accordingly perhaps be speaking about “knowledges” instead.

The outcome and lesson of this is that knowledges have to be understood within the context of the culture in which they exist and have a meaning. Knowledges represent the truth, yet are at the same time relative. Efforts to define, or else describe, knowledge accordingly as a rule focus on this aspect or character of knowledge. In this way, while “knowledge” is understood to mean something that is believed and is true, “information” can be described as data arranged in meaningful patterns. Thus, whatever particular knowledge object is the focus (here understood as “information” or “data” or, invoking anthropology, the term “cultural trait” – for example, a rule about allocation of group property rights “ would mean much the same), they have to be understood within the context of the particular culture in which they occur, are being used and have a meaning. Data and information used, for example, as input into a GIS application, is often taken out of the context of which they are a part. In this way, “meaning” and “knowledge” turn out to be closely related. When it comes to the present usage and application of GIS we are specifically addressing natural resources and their management (where the word “management” is culturally specific, and simply another term for the knowledge existing in this culture about natural resources and the environment more generally). This includes not just names in the vernacular language for, among others, plants, animals, features of the landscape, and so forth. In fact this is just the overt feature of knowledge about the environment. More than that, the knowledge in question deals with how a culture has come to understand its environment, which, in turn, determines how it is using it. There is enormous variation in how cultures see, define, assess, understand, relate to, and use specific – often the same – elements or features of the environment. Different cultures socialize its members differently, not just at the overt social level, but at the level of "cognition". This is a fundamental part and basis of the make-up of a culture's knowledge system. To be true to a culture, our approach to mapping and use of GIS will have to focus on, access, and utilize the relevant "cognitive spatial knowledge".

Thus, instead of seeing the culture and its environment as separate entities that interact, we should perhaps better understand it as an integrated unit whose elements are discussed apart for analytical and heuristic purposes. The further we move along the complex-simple continuum towards the simpler cultures (understood in terms of their cultural inventory, and not in terms of their position on the evolutionary ladder), the clearer this close-knit integration becomes. One well-known example is the Inuit, where the difference between Culture and Nature is blurring, and it may be a question of personal preferences where we place the dividing line between the two. In this way, is the tool used to fashion snow into manageable building blocks for *igloos* an extension of Culture (into Nature) that enables the construction of the "igloo", or does it belong in Nature? A parallel argument can, in fact, be made with regard to the "igloo" itself.

Language is an important factor to consider when it comes to knowledge, especially in the context of development communication. The fact is that a language is at one and the same time both the storage space, so to speak, of a culture's accumulated knowledge about its environment and the relationship with it, and the means by which such knowledge is communicated, inter-culturally and more and more also intra-culturally. The global *lingua franca* for communicating with, as well as about, GIS hardware and software increasingly is English. This means that small local or indigenous languages, as repositories of and links to traditional culture and knowledge about Nature and Nature-Culture relations, are not being utilized. In fact, these languages are fast being replaced by English and a few other global / colonial languages.

Management of this knowledge is an ever growing concern, and *knowledge management* (KM) has become important. This is so largely because of the enormous amount of data and information being made available and considered to be relevant, but also in connection with efforts to try and introduce or impose some form and level of quality on the data / information, in the form of applying relevant cultural analytical and contextual frames of reference. There are three key dimensions to KM: (1) Sharing knowledge, (2) The reach of ICTs and (3) Explicating knowledge. To share knowledge is a fundamental human need and activity. The reach of ICTs has, through KM, acquired a new dimension to sharing knowledge. Explication involves capturing, organizing, and disseminating knowledge. Key dimensions of knowledge management activities will involve decisions concerning: (1) With whom to share, (2) What to share and (3) How to share. As will be evident, GIS can and should be analyzed as a large-scale effort in KM. This is especially important to realize as KM has fairly recently begun to be applied to development cooperation, and because GIS applications are playing an increasing role here.

The connection between knowledge, including KM, and technology is central. Knowledge globally can be dichotomized into: (1) Western knowledge, which is instrumental and "scientific", and emphasizes information and data without the cultural interpretive context and (2) Traditional knowledge, which is found in much of the developing world and the countries in the South, emphasizes information-in-context and is variously referred to also as *local knowledge* and *indigenous knowledge*. As stated above, the problem arises when ICTs, including GIS, is being applied to the second type of knowledge. A key issue for all concerned practitioners, managers, and analysts is how to bridge the divide between these two broad knowledge categories.

2 Emerging concerns and reactions

As GIS software, including as produced and marketed by ESRI, are spreading globally, efforts to try out other, supportive, and/or complementary approaches and avenues are also growing. The reason for this does not so much come from a dissatisfaction with this software, as much as from a growing realization of its limitations and inadequacies. This comes about as a result of rational decisions by a number of people (and possibly also organizations) (as opposed to the impacts of an abstract macro-level structure), and there is probably no easy way to characterize these people as a category. In fact, given that their rationale and driving motivation differs so much, they may not have much in common save a determination to achieve reliable results that works for local people. Factors that drive this critique of the mainstream, high-tech software packages include the following: (1) High purchase cost, (2) High maintenance and upgrade costs, (3) Difficult to learn, (4) Proprietary code (comes from the open source advocates), (5) Relevant data are collected at the local level, often by outsiders, and removed for further processing, (6) Local people are only to a limited extent involved in the process, (7) Local people as a rule do not have a decisive say in determining research questions, priorities, methodologies, and goals, (8) The output is not easily or necessarily given back to the local level, (9) Output is often not delivered back to and disseminated to the local people, and (10) Output is often assessed by local people to be less useful than it is for outsiders.

These critics accordingly set out trying out their various ideas. Since maybe the early 1990s a number of partly overlapping and partly diverging approaches have come about, and implementation and testing is ongoing. The common denominator for many of these approaches are that: (1) They begin with – as well as involve and engage – local people, culture and social organization, (2) Theory and practice, data collection and analysis, and implementation and evaluation go hand in hand and, specifically, are not separated in space and time, and (3) They end at the local level. Many of these approaches can be understood at least partly in terms of the traditional tendency to move from one extreme to another. Thus, given a critique of mainstream GIS understood in a narrow sense as a computer system that utilizes geographically referenced information, many of these approaches aim to construct methodologies that are broader oriented and less reliant on proprietary technology. Thus, the extent to which computers are used varies from to some extent to not at all. The output is often not in electronic form, and will, according to some, only qualify as "GIS" following a "broad and generic understanding".[6/]

It is not so easy to make an inventory of these approaches, given disagreement over the use of labels, or rather what the labels cover, and also because the field is continually changing. A provisional list of the major approaches and methodologies would certainly include the following: (1) Community integrated GIS (CiGIS), (2) Counter mapping, (3) ethno-cartography, (4) Mobile Interactive GIS (MiGIS), (5) Participatory GIS (PGIS or P-GIS), (6) Participatory Action Research Mapping (PARM), (7) Participatory Mapping (PM), (8) Participatory Rural Appraisal Mapping (PRAM), (9) Participatory Research Mapping (PRM), (10) Participatory Resource Mapping (PRM), (11) Participatory 3-Dimensional Modeling (P3DM), (12) Participatory Spatial Information Management (PSIM), (13) Power mapping, (14) Public Participation GIS (PPGIS), (15) Remapping and (16) Social mapping.

These approaches, which are more or less overlapping, are, in turn, to some extent being applied in conjunction with a host of participatory approaches to applied and research work, including:

[6/] URL: http://en.wikipedia.org/wiki/Gis.

(1) Farming Systems Research (PSR), (2) Méthod Active de Recherche et de Planification Participative (MARP), (3) Participatory Action Research (PAR), (4) Participatory Learning Methods (PALM), (5) Participatory Rural Appraisal (PRA) and (6) Rapid Rural Appraisal (RRA). Conversely, several of these approaches have been developed within these same participatory approaches.

2.1 Two approaches presented

Two of these methods or approaches deserve special mentioning, the first for its radical approach to involving local people, and the second for it broadness, adaptability, and promise of broad acceptability.

2.1.1 Participatory 3-Dimensional Modeling (P3DM) [7/]

This is perhaps the most radical approach in terms of breaking completely with GIS understood in a narrow sense. Here the necessary geo-referenced data are painstakingly constructed by local people working together with outside facilitators, as they build actual physical models of the area in question, complete with information about streams, topography, vegetation cover, infrastructure, human intervention, etc. The final model is a great tool for discussing management of the available resources, for sorting out disagreements and conflicts, and for arriving at agreements on how to proceed. Computer systems and GIS are also used, for example, to produce maps.

The process of making the physical model is probably as important as the output itself. At the same time, some would argue, this approach takes a lot of time, and scaling up the data, as well as making the data useful to others and in other settings, is next to impossible. However, while P3DM may not produce data that can be used in comparisons, specifically cross-culturally comparisons (or certainly do not lend itself easily to such comparative analyses), the essence of this approach – as indeed with all these approaches – is the *methodology* and its toolset, or, in broader term, *the process,* that can be shared and reused, and not the output itself.

One limitation with P3DM is that it can be used only if sufficient permanent landmarks are available in an area, for example, mountains, hills, rivers, etc. It follows that this approach is not so suited to areas with little or no differences in topography.

2.1.2 Participatory Mapping

This approach had its beginning (1) Theoretically and practically – in the methods of participants observation (as originally developed within anthropology) and collaborative research methodologies involving participation of all relevant stakeholders, social action, and justice and (2) Geographically – in Latin America. Sometimes labeled “counter mapping”, “power mapping,” and “social mapping”, it emerged in the encounter and interaction of, on the one hand, indigenous peoples and, on the other hand, an assorted and eclectic assemblage of various outside stakeholders, including environmentalists, human rights activists, and researchers. The essence of this approach is that it recognizes the cognitive environmental and spatial knowledge of local people and transforms it into conventional form, for example, as maps. The output is *cartography* that often challenges existing mainstream positivist ideals and approaches to producing geographic information.[8/]

As will be clear, PM is a specific tool but at the same time also a generic name for a number of specific methodologies. The most discerning differences between these may be in (1) The emphasis or weight they place on involving local people and (2) The emphasis or role played by GIS. These two aspects are corollaries in the sense that a strong emphasis on involving local people may mean a

---

[7/] URL: http://www.iapad.org/p3dm_guiding_principles.htm.

[8/] URL: http://en.wikipedia.org/wiki/Cartography.

corresponding less use of GIS. The P3DM approach presented above may be understood as PM, specifically belonging in the PM sub-category of PARM (other sub-categories include PRAM and PRM, as in participatory research mapping).

2.2 Assessment

A detailed inventory of the available methods is not possible at this point in time, as not enough information is available on each of them. Moreover, a common analytical and comparative framework would need to be developed. Suffice it then here to present a simplified model in the form of a dichotomy based on a key variable, namely the extent to which local people is involved in the work and process at the local level, incl. when they are involved, which stages, what type of input, which responsibilities, etc.[9/] At one end of this dichotomy we find approaches where local people are not involved at all. The rationale of the approaches discussed here is that local people ought to be involved in one way or another, and thus we do not find any of these approaches located at this end of the dichotomy. However, as GIS understood in a narrow sense deals with technology, and is a form of remote sensing,[10/] it could be argued that GIS itself belongs at this end of the dichotomy. As we move along the dichotomy, we will find a number of people-centered, labour intensive, more or less time-consuming, cost-effective, local capacity-focused, and small-scale approaches. Located very close to the other end of the dichotomy is Participatory 3-Dimensional Modeling (P3DM) with its very strong reliance on input, broadly understood, of local people. One of the approaches, Participatory Mapping (PM), which will be addressed in more detail below, will likely be located near the center (the project that Supras currently is implementing in Mauritania, namely Technology Fosters Tradition (TFT)[11] is an application of PM). It is important to realize that these approaches do not exist on this dichotomy as mere points, but as more or less overlapping continuums in their own right. This is so because the internal degrees of freedom on how to understand and implement an approach means that variations and adaptations often occur in actual implementation.

It is important to understand that computer systems may be used in some or several of these approaches, at one or another point in the process. However, this will as a rule be as a free-standing component that is not integrated with the other components. A computer system may, for example, be included at or towards the end of the project or process, in order to display geo-referenced information aimed at the outside, specifically macro-level national- and international stakeholders.

3 Lessons, linkages and synergies

Whether a high-tech approach, intermediate technology, or small-is-beautiful approach is used, from the point of view of spatial analysis[12/] there is no difference in terms of usefulness. Or rather, the issue of degree of usefulness does not enter, as these approaches should not be pitted against each other. The situation regarding these different approaches is not that only one of them is acceptable and the others are not. In other words, we have to focus away from the technology as such and instead focus on the people and structures *behind* the technology, and their motivations, values, and goals.

The key questions to be posed accordingly should be: Useful for *what*, Useful *where*, and Useful for *whom*? The answers to these questions will differ depending upon who provides the answers, and possibly also on who asks the questions. In assessing such answers, it is important to understand that

---

[9/] These variables, in turn, are often related to another key variable, namely whether a computer system is used and, if so, when in the process it is being used. At its extreme this can be understood as an inverse relationship in that increased emphasis on involving local people often means increasingly less reliance on using a computer system.

[10/] URL: http://en.wikipedia.org/wiki/Remote_sensing.

[11/] URL: www.supras.biz/library/web/tft/.

[12/] URL: http://en.wikipedia.org/wiki/Spatial_analysis.

there will be acceptable and necessary eclectic as well as time/space constraints operating, in that different needs, stakeholders, and circumstances may warrant use of different approaches and methodologies, at different points in time and localities.

In this way it becomes clear that it is not just people that select specific technologies to perform specific tasks, but that technologies also select specific people, as it were. For example, it is not accidental that civil society groups use P3DM or PM (see para 2.1 above), or that a majority of stakeholders in the West employ variants of traditional mainstream GIS.

The fundamental view behind Supras' approach to using GIS in development cooperation is that: (1) This has to follow from the lessons of role of ICT in development cooperation, as well as the value- and knowledge-specific nature of the relationship between technology and culture and (2) An eclectic approach is necessary in order to achieve our goals. Towards this, Supras argues for a fusion of traditional mainstream GIS with the alternate methods outlined above that are based in local culture and emphasize local knowledge. This represents an optimal and adaptive approach for collecting relevant data. This model will be presented next.

4 Social Geographic Information Systems (SGIS)

An eclectic as well as socially and culturally sensitive approach to working with GIS should take these facts into consideration, and for a number of reasons. Supras' approach to using GIS, that is, the various approaches to doing GIS together with their underlying rationales, has come to be called "Social Geographic Information Systems" or simply "Social GIS" (SGIS).

Supras' approach to SGIS stems partly from the experience with implementing the Mauritania Technology Fosters Tradition (TFT) project,[13/] partly from work on Environmental Trends Analysis (ETA),[14/] and partly from being involved in the ETA Core Group, part of USAIDs FRAME project.[15/]

4.1 Introduction

A discussion of the history of term "Social GIS" itself would seem to be in order at this point. The term has been in use since maybe the mid-1990s. There does not appear to be a clear and agreed upon view of how to define it. As a matter of fact, it appears to have been used by different people, and at different times, within different disciplines, to mean different things. A key usage appears to be in connection with analysis of secondary (perhaps also primary) survey and census data, and another usage appears to be within archaeology. In an effort to delimit or circumscribe the term, if not define it, some authors state that Social GIS is concerned with the social *as opposed to the environment*.

This provides some clarification as to these earlier usages of the term, and at the same time helps clarifying what the difference is with the usage in the present context. The early – albeit vague – usages refers, it would seem, to the social in the sense of a set of methodological tools or approaches, a vaguely social-science influenced stance that are brought to bear on hard quantifiable data, and where the environment is *a priori* left out of the equation altogether.

4.2 Scope

SGIS in no way represents a critique of mainstream GIS, rather it is an effort to *extend* it into the social-cultural field, and try to structure such a more inclusive approach. It follows then, for example,

[13/] URL: www.supras.biz/library/web/tft/.

[14/] URL: www.supras.biz/portfolio/research/eta.html.

[15/] URL: www.frameweb.org.

that SGIS is positioned solidly with a broad understanding of the term geospatial analysis[16/] which covers areas like surface analysis, network analysis, and visualization (cf. also the term geomatics[17/]).

Against this, the present usage is concerned with the "social" in the sense of relations and communication within as well as between groups, individuals, institutions, organizations, and other collectives. These relations and the communication taking place are based within a common reference structure consisting of cultures, languages, and values.[18/] Furthermore, the concern is not just with relations that are internal to Culture, but also with the interaction between Culture and Nature. This is to some extent related to the position that Nature is defined and constituted by Culture. In other words, the environment is very much part of the present understanding of what "Social GIS" or SGIS is. The goal of SGIS is to achieve an optimal – yet adaptive – integration of, on the one hand, GIS, with, on the other hand, social concerns and considerations.

4.3 Focus

SGIS as an analytical stance and a methodological approach has come about and is being used by Supras following the realization that there are different ways to work with GIS. Which method to chose in a specific situation and locality would depend on a series of factors, including the stakeholders involved, characteristics of the local population more specifically, the needs and means available, and the goals. While there may be weaknesses with one method (as viewed from the point of view of another method) there will also be advantages. Thus, rather than viewing them as irreconcilable and contradictory (as proponents of each extreme position may be want to do) a more useful approach would be to view them as filling different needs, on the one hand, and as complimentary as well as building upon each other, on the other hand. The latter point is crucial, in that output of one approach can provide the foundation and starting point for work in another approach. Moreover, experiences with one approach can potentially benefit the other approaches.

The hallmark of SGIS is that it is cross-cultural, culture-relativistic, and inter-disciplinary. It is *cross-cultural* because it aims at as well as favors cross-cultural comparison. It is *culture-relativistic* because it accepts and builds upon the realization that cultural facts are the product of cultures and have to be understood within that context. Finally, SGIS is *inter-disciplinary* in that it is the nexus of work in a varying number of disciplines, including economics, geography, natural sciences (specifically biology and ecology), and social sciences (specifically anthropology). The essence of SGIS is that it does not advocate a specific approach, but provides ways of thinking about and analyzing a local situation that will provide guidance on how to implement a particular GIS project. At the same time it is process oriented (as opposed to being a blue-print), and in this way SGIS can provide guidance throughout the implementation period. There is one area where this is particularly relevant, namely when it comes to identifying, understanding, and addressing conflict, for example, in connection with boundary disputes and addressing right-of-way for pastoral migration routes. The dominant approach to doing GIS is not equipped – or certainly not optimally equipped – to handle such issues.

Essentially, SGIS owes a lot to social anthropology, directly and indirectly, including its analytical stance and specific methodological approach to problem identification and solution. While anthropology is an important point of departure for the alternative approaches to doing GIS, there may, however, still be important lessons to be learnt. The essence of the SGIS approach is the combination of spatial software with both qualitative and quantitative terrestrial datasets.

16/ URL: http://en.wikipedia.org/wiki/Geospatial.

17/ URL: http://en.wikipedia.org/wiki/Geomatics.

18/ Cf. the arguments above on the difference between *information* and *knowledge*.

4.4 Goals

These are a number of key goals with SGIS, addressing specifically social/cultural/social organizational trends (here abbreviated as "social trends") and their connection with selected environmental trends:

1. Identifying and quantifying critical and emerging social and environmental trends, and the relationships between them,
2. Assessing the consequences of different environmental and social trends, including the connections (positive/negative feedback) between them and their synergies,
3. Identifying and measuring underlying causal links between probable environmental and social futures and the underlying economic drivers of change,
4. Developing or applying methods and models to assess environmental and social futures,
5. Measuring the impacts and consequences of environmental and social futures, and
6. Identifying appropriate strategies and policies to manage and adapt to environmental and social change.

It follows that SGIS should aim to produce output that can be used in "Social Trends Analysis" (STA).[19/] STA is here understood as data, methodology, and analysis that aim to address developmental trends in selected key social variables linked to Natural Resource Management (NRM). STA would contribute to assess the "Social sustainability" of, for example, a people, an activity, a culture, a village, or a region, and in this way be an important adjunct to "environmental sustainability."

4.5 The SGIS model

The theoretical foundations of the Social GIS model have been addressed above. On the practical level of implementation, this translates into a Social GIS model that consists of two separate yet closely linked parts, namely GIS and Participatory Mapping (PM). During implementation the two parts will be implemented partly in parallel and partly serially. Throughout the process, they interact and this may result in the necessity of making changes in actual implementation. This means that choices under one step often will impact or determine choices under a later step.

The overall implementation of the model is to be understood as an unfolding process, and a particular step in the process does not necessarily follow from the preceding one, as described in this manual (see paras 4.5.1-4.5.3), but may be changed according to experiences. Put differently, each step listed here do not necessarily follow from the preceding step. The manual is accordingly organized as a decision-tree approach for how to construct a specific SGIS application that is optimally adapted to a specific situation and locality. This means that decisions and choices made in anyone step may impact, determine, channel, or facilitate, the choices to be made in the following steps.

The essence of SGIS is how to connect and integrate these two elements of GIS and PM. The point of departure here is that: (1) GIS has to adapt to the specific local situation and (2) The specific character of PM to be used has to be decided upon.

4.5.1 Geographic Information Systems

In this part GIS has to be adapted to, or targeted at, the specific local situation. The part consists of remote sensing technology, specifically satellites, and satellite mapping technology, GIS software (e.g., ESRIs ArcView), and Global Positioning System (GPS). This part contains six steps, each

[19/] Environmental Trends Analysis (ETA) aims, according to some observers, to cover also social variables and Culture. However, in order to emphasize the importance of this part it would seem most correct to consider them apart and then, in the final analysis, combine the two (cf. also Annex 1.2).

consisting of one or more decisions to be made and tasks to be done. The steps are: (1) Satellite photography, (2) Choicoe of satellite photography provider, (3) Timing of satellite photography, (4) Defining frames, and (5) Use of Global Positioning System (GPS).

1. *Satellite photography*. The initial question here is whether to make satellite photographs or not. It is important to realize that this is not a necessary precondition. In several projects the necessary maps, in the form of simple sketch maps or physical relief models, are produced at the local level. Several considerations has to be made in order to decide this: (1) The features in the landscape one is interested is, (2) The kind of detail and correctness needed, (3) The availability and quality of existing maps, and (4) The ultimate target group or purpose of the project (essentially, local, national, or international). If the purpose is participative action research mapping then maps produced by the local people may suffice. However, if the target group is the public sector and/or the political apparatus in the capital, it may be necessary to go with satellite maps as the basis for the maps to be prepared. Also, if one decides to make satellite maps, it is not necessarily so that they have to be made at the beginning of the project, and this may not even be practical or optimal (cf. step 3).

2. *Choice of satellite photography provider*. It is crucial to get as detailed as possible images of the area in question. Of the available earth observation satellites, QuickBird[20/] (which was used in the TFT project) represent the best alternative for acquiring relevant satellite images. Quickbird collects the highest resolution commercial imagery of Earth, namely panchromatic imagery at 60-70 cm resolution and multi-spectral imagery at 2.4 meter and 2.8 meter resolutions.

3. *Timing of satellite photography*. It is important to take pictures when the cloud cover is as little as possible. This means that one should plan on making photographs during the dry season, and certainly not during the web season. Even so, because the satellite providers have their own criteria for optimal cloud cover, they will postpone shooting until near perfect conditions are available, and this means that one may wait for weeks until such time as the frames can be shot. If there are plans to utilize existing satellite imagery, for example, from Corona, it may be a good idea to make sure that the new pictures are taken at roughly the same time of the year. In areas that are inundated following annual rains, it is not a good idea to take pictures in the weeks and months after the rains for that reasons, as many features of the landscape will covered by water.

4. *Defining frames*. All satellite providers operate with certain given technological limitations. In the case of QuickBird this is mainly that a maximum frame for one pass of the satellite is 64 km2. Given this area, one can construct a suitable area that is optimally suited to the task at hand. This area will become part of the order itself, which will be uploaded to the satellite. Another consideration is the angle of photography. In any given pass, QuickBird can take pictures within a specific parameter of angles. This being so, during any one pass, it is possible to order photographs of areas that are not contiguous provided they are within the given maximum angle of photography.

5. *Use of global Positioning System (GPS).* Whether to use Global Positioning System (GPS)[21/] or not depends on a number of considerations, incl. costs, availability of local staff to use them, and actual need (the latter depending largely on whether the more exact location that GPS provides is really necessary).

[20/] URL: http://en.wikipedia.org/wiki/Quickbird.

[21/] URL: http://en.wikipedia.org/wiki/Global_positioning_system.

The individual and collective decisions and choices made in Steps 1-5 above will impact or determine the choices to be made under the following stages.

4.5.2 Participatory mapping

In this part the specific character of Participatory Mapping (PM) to be used has to be decided upon. This will depend on a number of considerations, incl. resources available, time at hand, capacities of the local population (are they available, do they have the necessary training or understanding, are they willing to receive training, etc.), and goals with the exercise. Essentially, other variables kept constant, the extent to which the data collection can be done in a participatory way depends on the capacity of the local populations. This part contains six steps, each consisting of one or more decisions to be made and tasks to be done. The steps are: (6) Assessment, (7) Data collection, (8) Output I (of the field tasks), (9) Integration with GIS, (10) Output II (of the integrative step with GIS), and (11) Feedback to the local people.

6. *Assessment*. Involves operationalizing the project document(s), that is, addressing essentially *how* to achieve project goals. The primary and necessary condition is that the local involvement is to be maximized, at all steps in implementation.
   - *Overall situation*. Does the project documentation provide a realistic and correct picture of the situation at the local level?,
   - *Human capacities*. Are there local people that can work on the project? If so, do they have the necessary capacities, read: training? If so, are they available, and when are they available?, and
   - *Means*. What are the implications of the answers for how the project is implemented, that is, what means to employ to achieve the goals? This involves specifically decisions on the extent to which local people can be involved in this step of the overall mapping exercise, and what their responsibilities and tasks will be.
7. *Data collection*. This concerns collection of the necessary data to be used in the mapping. An important factor to consider here is the earlier assessment of local human capacities (see Step 6). In general, it is necessary or advisable to identify and organize the collection of minimally four sets of data. These can be collected by means of either (large-scale) surveys using prepared questionnaires or else using key informants and depth-interviewing. Combinations of these two are of course possible. In the case of an area with many villages and people it is advisable to sample the population at the level of households.
   - *Socio-economics*. Necessary for context, description, interpretation, and analysis,
   - *Toponymy*. Locate in space the locations where resource utilization are taking place,
   - *Resource use*. Who does what, where, when, why, how, and with what outcome, and
   - *Common property rights*. Who have what rights of use and ownership to what type of resources, and located where? Who recognize these rights?

   In the case of collecting data on toponymy, resource use, and common property rights, it is convenient to organize this as group interviews. Moreover, it will be very useful – for several reasons – to provide opportunities for respondents to draw simple sketch maps to illustrate their responses regarding the location of place names, where specific resources are found, and the location of areas under specific property rights.
8. *Output I*. This is the first step of outputs (cf. step 10 which also contains output), and applies to projects where satellite imagery is not used, and where maps are made locally with a usually heavy input of work and knowledge by local people. In case of large-scale data collection exercises it will be necessary to enter the data into a database for analysis, to be followed by

map making based on available satellite photographs or locally available topographic maps. In either case, this may be done locally or elsewhere.

- *Data assessment*. Quality and preliminary analysis,
- *Creating a database*. In the case of larger data collection exercises, using surveys with several questions and respondents it will be necessary to create a database. This will typically be made using a relational-type of database program, for example MC Access,
- *Data analysis*. To be done by means of a relevant program, for example, SPSS,[22/] and
- *Mapping*. In the case of projects that do not rely on satellite imagery, the necessary map(s) will be made locally together with local people, for example, building physical models as in P3DM.

9. *Integration with GIS*. In situations where satellite images have been made, or where available local topographical maps have been digitized, it is necessary to combine the two, that is, the digitized maps and the relevant data that were collected (cf. Step 7). This requires some necessary preliminary work and consideration.
    - *Vision*. Discuss and reach agreement with all relevant stakeholders, specifically the local people, the overarching goals with the maps (this should have been discussed at the preparation stage, but it may be necessary to go through this again in light of the experience gathered during implementation. Who will the maps be aimed at? What purpose do they serve?
    - *GPS*. Depending upon the quality of the data regarding locations or resource usage, etc., it may at this point be necessary to ground-truth the data using GPS,
    - *Conflicts*. The data gathered will, as a rule, speak to potential or latent, or emerging conflicts between different groups, usually along lines of kinship, ethnicity and/or subsistence practices. It is important that the respective stakeholders reach agreement on the overarching principles for how to represent these types of data, in order to ensure final acceptance by these same groups,
    - *Strategy/Tactics*. What to include, and how to include it, will depend on strategic/tactical considerations, including the relationship between the local and the national level, what the national level know about the local level, and what is assumed to be realistic in terms of goal achievement,
    - *Thematic layers*. Depending on the amount and character of data, it is advisable to locate data on separate thematic layers. Some general advice on what type of data to be added to which layer might be considered,
    - *Temporal data*. Agree on how to include data collected at different points in time, and
    - *Legend*. Reach agreement on symbols to be used. This is no small matter, especially in situation of opposing groups claiming rights of use and/or access to specific resources.

10. *Output II*. This is the second step of outputs (cf. Step 8 which also contains output), and applies to projects where satellite imagery is not used. This is the actual process of adding the relevant data to the digitized maps. This work may or may not take place locally. The program used could, for example, be ArcView.
    - *Map creation*. The actual process of adding data to the digitized maps.

11. *Feedback to local people*. This is the crucial step of giving the outputs, as it were, back to the local people.

[22/] URL: www.spss.com/.

- *Feedback.* In projects that rely strongly or largely on use of local input this process will often be noticeably easier, as well as have greater effect. This is the case on the short term, but especially on the longer term.

4.5.3 Macro-level integration and implementation

This concerns the important part of the strategy and tactics to be followed and employed once the product, that is, the map or maps, are ready. Above, a number of key steps in the SGIS model have been outlined, together with the decision-making process that determines the partly parallel and partly serial nature of the implementation of the model. Having arrived thus far, as will be clear, it becomes progressively more difficult to provide clear-cut advice and guidance for action. This is so because the tasks at hand are not any more contained to the techniques of employing GIS and PM, and doing so at the local level. Quite to the contrary, at stake now is to engage the larger society, including the civil society and public sector, but especially the political apparatus. Here there are few known factors and correspondingly many unknown ones. This part contains three steps, each consisting of one or more decisions to be made and tasks to be done. The steps are: (12) Analysis, (13) Tactics/Strategy (Integration) and (14) Politics.

12. *Analysis*. This involves integrated analysis of the available information and knowledge. To be done from the point of view of what this will be applied to, that is, reaching certain goals. Meaning, focused on the output, or on what conclusions to draw in terms of what should be done.
13. *Tactics/Strategy (Integration).* Prepare a plan for reaching the goals. Including whom to involve, and on doing what.
14. *Politics (i.e., actual implementation).* The model aims at the practical and technical aspects of producing cartographic output. What happens next is not part of the model. This is so because the political-economical-social situation at the local and national levels in a country together with the combined goals-means set-up of anyone project will differ often markedly. In this situation it is difficult to give anything but general advice.

5 Discussion

Some unanswered questions as well as challenges remain with developing SGIS as model to make it optimally and practically suited to planning, implementing, and analysis, using geographically referenced information. The emphasis in this explication should be on using socially and culturally relevant knowledge. It should be noted, though, that there are clear limits as to how detailed and complex the model can be made (this is in the nature of modeling itself). Also, the goal is not to provide a straightforward checklist for project implementers.

The following concerns and arguments, relating to issues to be addressed, and presented in no particular order, are noted:

1. Some details of the model need to be ironed out, with the aim of making it a useful and practical tool,
2. Finding solutions to how to incorporate processual types of data. That is, extend the utilization of GIS and maps from covering only singular data (that occur at a point in time) to cover also data that show process unfolding in time, and also in space). This would be very important for the application to Environmental Trends Analysis (ETA) (see Annex 1.2),
3. Identification of variables,
4. Discuss optimal operationalization, including pro et contra arguments,
5. Types of expertise/experts needed,

6. Time needed,
7. Streamlining of data collection and overall data collection,
8. Use of GPS,
9. Create one or more relational databases (e.g., MS Access),
10. Use of SPSS in analysis,
11. Potential use of STELLA, NetWeaver(TM) and/or GeoNetWeaver(TM) (see the bibliography[23/],
12. Map production vs. data analysis – Two partly different outputs, using the collected data,
13. ETA and scenario building,
14. Strategic considerations with reference to national level public sector and the political order,
15. The overall role of SGIS in the context of development cooperation,
16. Operationalization of social and cultural phenomena, in essence, reducing knowledge to data without losing (too) much,
17. Social GIS and related approaches pro et contra. Emphasis on comparative advantages and strategic issues. For example, PGIS (and also PPGIS), where Social GIS may, other variables being equal, be advantageous because it takes less time,
18. Inter-disciplinary constraints and opportunities (with an emphasis on the former) in communication across disciplines. One important issue concerns *terminology*, where GIS and social sciences may use the same terms to mean different things (possibly also vice versa). A good example is "network" which variously means a connected graph of GIS objects that can be traversed (GIS), and interpersonal relationships and the manner in which these are arranged to form a pattern which may be termed a social network (social science, specifically anthropology),
19. Application to / Relationship with Environmental Impact Assessment (EIA), and
20. The complex relations between the social fields and knowledge, on the one hand, and technology, on the other hand, will only to a limited extent be touched upon here (see the bibliography for relevant literature.[24/]

6 Conclusions

SGIS is, first, the connection of technology (represented by GIS and GPS) and social science and participatory approaches and methodologies (represented by PM) aimed at understanding local NRM. Second, the nature of this connection is such that the parts are optimally integrated, they feed into and reinforce each other. Third, the focus is on how to produce relevant and integrated information and knowledge with the highest possible validity and reliability using a local-level participatory mapping process, and, fourth, it guides and supports integrated analysis of this information and knowledge, while throughout emphasizing the timeliness and economics of the overall exercise.

SGIS represents Supras' approach to working with GIS, and to integrate GIS in its participatory approach to project design and project implementation as well as research. Supras' primary interest in SGIS is in how it can contribute to:

- *On the short term*. Understand, represent, and visualize actual occurrences and patterns in NRM at the local level, at specific points in time as well as over time, and
- *On the longer term*. Develop the analytical and policy level concerns of Social trends analysis (STA) and Social sustainability.[25/]

[23/] URL: www.supras.biz/knowledge/research/socialgis.html.

[24/] URL: www.supras.biz/knowledge/research/socialgis.html.

[25/] URL: www.supras.biz/ortfolio/ict/socialgis.html.

At a micro-level, this paper argues for increased understanding of the complexities and problems inherent in working with culture in a technological context, specifically in efforts to operationalize this knowledge in the process of importing it into GIS applications and in so doing reduce its content (i.e., removing the qualitative, contextual knowledge). At a macro level, the purpose of the paper is to contribute to a discourse on the use of technology, specifically ICTs (incl. GIS) in development cooperation. This is done through exploring the interconnections and feedbacks (positive and negative) between technology, communication, and knowledge.

SGIS can contribute to achieve a number developmental goals connected with sustainable management of natural resource: Empowerment, equality, equity, inter-cultural communication, legal reform, participation, poverty reduction, reduction of conflicts, and transparency.

Finally, SGIS should be understood as a potentially potent tool in *strategic communication*, in presenting information as well as knowledge that are relevant to all parties that will result in an informed, transparent, and public participation process, as well as decision-making that are beneficial for all parties concerned.

Annex 1: Applications

The areas to which the SGIS preparation, planning, and implementation approach could suitably be applied, and trade-offs between utilizing one or another approach (or a suit of approaches) have already been hinted at. In practice, however, it will largely be limited situations where there is a close collaboration between external agencies/donors/NGOs and local organizations/NGOs/people, where civil society is fairly developed and organized, where the focus is on the close relationship – in the past as well as the future – between Nature and Culture, and where the public sector and the political level is interested in supporting increased involved in NRM at the local level. Examples include: Biodiversity conservation, conflict management, poverty reduction, protected area management, resource flow mapping, and tenure mapping.[26/]

Some general observations and suggestions on two specific areas of interest to Supras, namely poverty reduction and ETA, follow, based on the following joint analytical framework: (1) Overview, (2) Data (type of data), (3) Methodology (emphasizing differences), and (4) Concerns:

1.1 Poverty reduction

Poverty reduction (or poverty alleviation) is a very large and very complex area, involving a country's macroeconomic, structural, and social policies, together with programs to promote growth and reduce poverty. Countries are increasingly working on developing and supporting comprehensive country-wide poverty reduction strategies. Two key sets of issues in connection with reducing poverty are: (1) Identification of effective strategies to reduce poverty and (2) Modification of external partnerships and assistance to reduce poverty more effectively. As such, poverty reduction strategies operate largely, or at least initially, at the macro-level, while they at the same time have impacts and corollaries at the local level.

The present concern is with NRM, including policies (macro-level) and actual management of natural resource (local level). While this is a specific focus within the overall poverty reduction strategy framework, it does not necessarily mean that things are any easier. Actual local NRM is still very much embedded in: (1) A national political, administrative and bureaucratic context and (2) Cultural and social contexts and value systems. The term "poverty-environment nexus" represent an effort to pinpoint the focus and variables involved in understanding and addressing occurrences of poverty and how to address and reduce poverty. Again, this represents an effort to simplify and to model complex relationships. Any serious effort to understand and target poverty has to go beyond these overt and simple correlations and positive and negative feedbacks, and address the underlying complexities.

Technology, specifically ICTs, can be important tools in this work. This applies also to GIS. However, GIS cannot be more than a tool and a means in this work, and should not be understood and promoted as such.[27/] A realistic point of departure for work involving GIS has to be that it is a tool that, in conjunction with other approaches, specifically as found in social science and participation, together can lead to results.

[26/] The TFT project is an example of resource flow mapping and, by implication, also of tenure mapping.

[27/] At the GSDI 9 conference (Santiago, Chile, November 23006), I participated in an ESRI sponsored plenary workshop on "GIS: the spatial information platform for reducing poverty." A handout states that "GIS is a foundation for Spatial Data Infrastructure (SDI) (http://en.wikipedia.org/wiki/Spatial_Data_Infrastructure) and poverty reduction." It is of course a matter of interpretation what the word "foundation" means, but my feeling is that the intended meaning goes beyond "technical foundation."

1.2 Environmental trends analysis

Environmental Trends Analysis (ETA) is presented elsewhere.[28/] Briefly, the challenge to ETA in connection with GIS may be that ETA is concerned a priori with temporal data, and thus cuts across and is of interest to all the above approaches.

The focus here is on the connection between SGIS and ETA. In the interest of utilizing data with high reliability, validity and relevance, and in order to produce outcomes (i.e., predictions), detailed context specific and user generated data would seem to be a priority in ETA. This type of data are typically produced at the local level, employing labour-intensive and culture-contextual approaches, that typically will be located in the above dichotomized model in the vicinity of where PM is positioned.

Supras’ approach to applying the SGIS analytical model and implementation approach to ETA is partly based on the experiences with implementing the Mauritania Technology Fosters Tradition project. Through trial and error the model arrived at aims to combine advanced GIS with labour intensive on the ground data collection using local people to the extent possible, largely depending upon their capacities. Briefly, the local level data are added to high-resolution satellite images by means of ArcView, to produce detailed maps of resource utilization at a particular point in time, actually a complete annual cycle (2003-2004). This constitutes a very detailed and comprehensive baseline. A second time period would be constituted by selected images produced by the Corona[29/] satellites in the 1960s, and the ETA would be done initially by simple comparisons of the two sets of images. The raw data of resource utilization from 2003-2004 would, in the event of a future survey to collect comparable data, constitute unparalleled possibilities for ETA in conjunction with analyzing detailed changes in patterns of resource extraction and utilization by local people.

[28/] URL: www.supras.biz/portfolio/ict/eta.html.

[29/] URL: http://en.wikipedia.org/wiki/Corona_(satellite).