Paper #: 1179 Session Title: GIS: A Tool for Humanitarian Action Date: Wednesday, July 14, 2010 Time: 8:30 AM - 9:45 AM Room: Room 30 D

Juerg Krauer
Centre for Development and Environment
University of Bern
Hallerstrasse 10
3012 Bern
Switzerland
juerg.krauer@cde.unibe.ch

Geoinformatics in support of peacebuilding, humanitarian assistance and development cooperation

Keywords
GIS, Sudan, Darfur, Crises, Geospatial Data, Mapping, Humanitarian Aid, Geoinformation Science, Satellite Imagery, Infrastructure management, Development Cooperation, Capacity Building

Abstract Accurate and updated geospatial information is crucial to provide effective support in peacebuilding, relief operations and reconstruction. From the very early stage of negotiations to final rehabilitation measures and sustainable resources management, geoinformation systems, maps and web applications developed by the Centre for Development and Environment (CDE), University of Berne, have been widely used at all decision-making levels within governmental institutions, UN agencies, and INGOs in Sudan.

1. Introduction

Political conflicts, natural disasters, and continuing over-exploitation of natural resources not only threaten the existence of many human beings but also constitute a major **challenge in terms of sustainable development**. Climate change, frequent floods, haboubs (sudden dirt storms), droughts, tribal conflicts and the long-lasting war between the north and south of Sudan are claiming the lives of hundreds of thousands and millions of displaced people, hampering all the processes of rehabilitation and development.
Along with providing emergency relief and supporting reconstruction efforts, measures to promote peace and strengthen human rights are the most important tasks undertaken by the **Swiss Department of Foreign Affairs (FDFA**) and the **Swiss Agency for Development and Cooperation (SDC).** The sustainability of all these cross-linked actions – and hence the availability of up-to-date geographically referenced information – are thus of central importance. This applies to all areas of security and humanitarian assistance in equal measure; the only differences are in the form and the content of the geospatial data, and the ways in which this information is made accessible for

many different tasks and users. Differences in need could not be greater: **rescue teams** need rapid large-scale maps with up-to-date information about infrastructure; **crisis management** requires immediate geospatial information for early recovery, procurement and logistics in overall measures; **peacekeepers** need a small-scale information base to support navigation and security management; **reconstruction specialists** focus primarily on existing information in facility management; and finally, **long-term rehabilitation and sustainable development** efforts must be based on a clear analysis of the situation, on modelling frameworks, or even on complex simulations.
Given the extensive options for preparing geographical information currently available, the different requirements of the international community for conflict management, emergency aid and reconstruction, and the clear need at local and federal levels of government to **strengthen institutional development, NSDI and human capacities** in Sudan can now be met to a great extent by the latest concepts in ICT (Information and Communication Technology).

2. Institutional set-up

The Centre for Development and Environment (CDE) is a Centre of Excellence of the University of Bern, and has been working for a good 20 years in the area of geoinformatics. **CDE's Geomatics Unit** has extensive experience in the use of communication technologies and earth observation systems in the following areas: crisis management, peacebuilding, humanitarian assistance, demining, climate change, watershed modelling, sustainable use of natural resources and issues related to census statistics and demographic development. Its products include reports, natural resources and topographic maps, socio-economic atlases and desk studies for governments and international organisations - mainly in Africa, and Central and East Asia. Networks, research, education, training and conceptual advice offered to partners are important foundations of this work. In Sudan CDE is strongly committed to capacity development and geospatial information management in support of local Universities, the Government of Southern Sudan (GoSS) and UN-agencies. NSDI and institution building in Southern Sudan is still at an early stage. Therefore, strong links to local governments could only be established with a few ministries but quite a few UN institutions.

3. Maps for mediation and peace building

Topographic maps are the most important foundation for peace negotiations, political decision-making, and demarcation. There are no up-to-date topographic bases for crisis regions in Sudan (i.e. Darfur, Abyei, Nuba Mountains, and Southern Sudan). In order to make current geographic databases available for the many tasks in the peace-building process, all spatial baseline information is stored in a file-based geographic information system (GIS) in **thematic layers**. Updating of old map sets using **current satellite data, Web portals** and **Internet sources** is of central importance in this regard. Little is taken directly from old maps: only the names of rivers, places and administrative units, to the extent they are still relevant (i.e. Russian Military Topographic Maps 1:100k and 1:200k). For the most part river

courses, contour lines, characteristics of the terrain and surface features are modelled on the basis of SRTM's radar data (NASA's Shuttle Radar Topography Mission) or TerraASTER GDEM data.
Infrastructure such as roads, trails, tracks, built areas, settlements and vegetation cover was extracted from current satellite images and transferred to the file-based '**Geospatial Database System Sudan'**.

Photos1&2: Nuba Mountains Ceasefire Agreement in 2002 (left) and the Governors' Forum, Juba, in 2006 (right): Cartography at the policy and decision support levels - history vs. recent geospatial information in the long-running process of peace-building and reconstruction.

4. Geospatial data and governmental collaboration

Most of the ministries and organisations in Southern Sudan maintain their own geospatial databases. Institutional **collaboration and data exchange are difficult** since working scales in geoprocessing and service provided are driven by corresponding demand. Interoperability was not in effect, and sharing of geospatial sources among the institutions was not at all developed – data access was sometimes even prohibited. Due to the lack of a common spatial reference system and shared information sources, integration of data of different origins was

not manageable and duplication was frequently observed. This is where CDE's project of nation-wide geospatial reference layers came in, with its baseline information for almost any kind of mapping and spatial modelling. Together with the annual handing over of data updates, modular training courses were offered to all governmental institutions and the international community (UN agencies and INGOs). The tailor-made capacity development programme was a key element in cooperation with governmental institutions and the handing over of the geospatial database was an argument for participation. ESRI and OpenGIS (gvSIG) software was used in the courses, and an analysis of existing institutions with respect to personnel, organisational structure, available geoinformation technology and geodata was carried out. Discussions about software strategies (commercial or open source software), geodata formats, standards, and reference systems are central issues in the work of **institutional integration**. Structural **strengthening of institutions** to the point of independence is probably the most important goal in applying geoinformatics to reconstruction and sustainable development in Sudan.

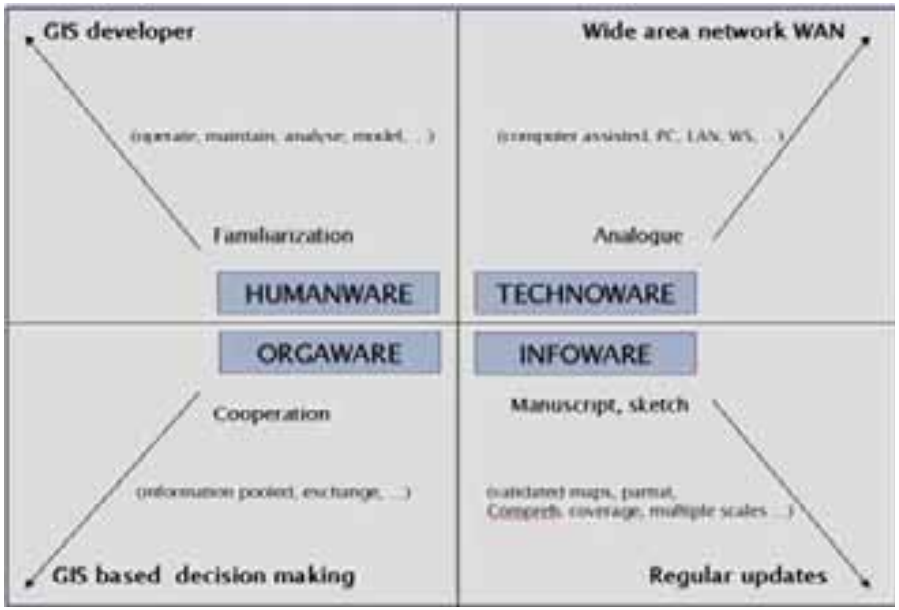

Figure 1 & Photo 3: The four dimensions of GIS as the basic framework for an institutional assessment carried out in Southern Sudan 2007 (left). Capacity development as a data and knowledge exchange platform (right). Education and training in geoinformation management is the key element in institutional strengthening (Inter-institutional ArcGIS and FOSS-GIS training in Juba, 2008)

5 Spatial analysis, modeling and capacity building in the framework of reconstruction and development cooperation

The development of sound models for decision support with **explicit spatial interrelations** (i.e. access to health facilities, rural population distribution, land cover change, harvest yield prediction, watershed modelling, etc.) is a further aspect with respect to investing large portions of a Capacity Development Programme in quality data acquisition and compilation. But here too it will be necessary to avoid high costs for acquiring data. SRTM and from 2008 ASTER GDEM data were used as a geographic reference. Both terrain models are probably available for the entire area, although baseline data in the extremely flat swampy region in sourthern Sudan (Sudd) had to be obtained from vectorised Russian maps. Not only were standard derivatives such as slope, aspect, profiles and altitudinal belts derived but also spot heights (mountain tops and river junctions), drainage systems, and delineation of watersheds (ESRI ArcHydro extension and Watershed Delineation tools).
In areas with few cartographic elements (infrastructure, relief) vegetation cover is an important cartographic structural element. Satellite images were thus one of the most important sources of data. TerraMODIS and Landsat ETM images provided an ideal complement as a basis for feature extraction, multi-temporal analysis, and image merging – all methods for structural improvement of topographic modeling and modeling of thematic map content. TerraMODIS imagery was analysed (mainly LAI and NDVI indices) for 2006-08 to provide information about land use types and land use change. Model validation and complementation finally require **close links with local institutions** and selected key persons who accompany the model development process over the long term. Background expertise and close **inter-institutional cooperation** were positive outcomes of the joint training programmes. The training platform was used to discuss responsibilities, to rethink data policy, sharing and standards, and to overcome obstacles in workflow.

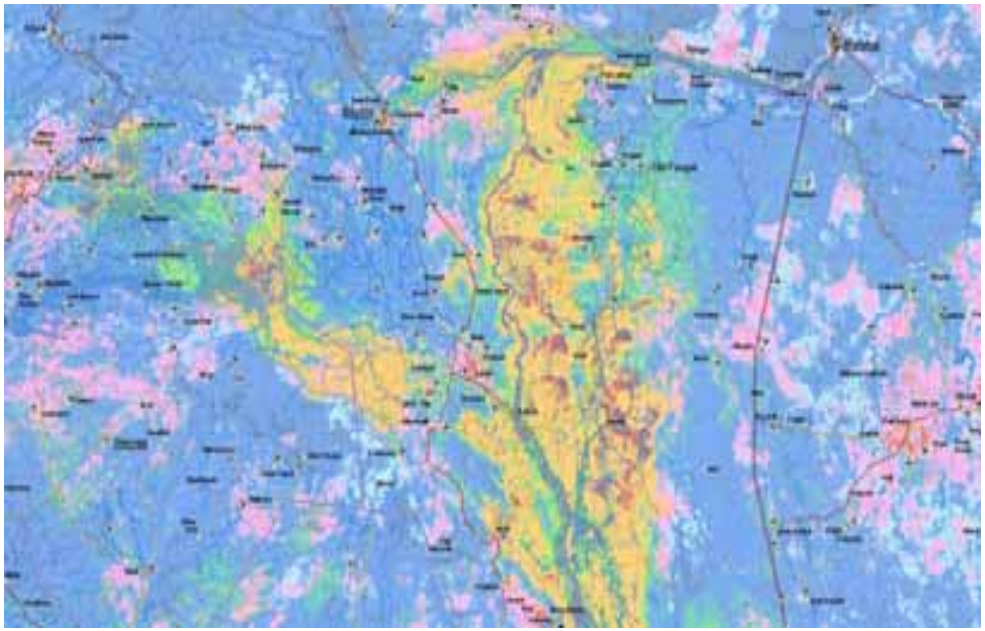

Photo 4 and Figure 2: Digital terrain modelling (SRTM, ASTER GDEM), hydroinformatics and multi-temporal image analysis (Terra MODIS) have been used to locate potential agricultural sites, develop irrigation schemes support lectures, and model change analysis

6. Webmapping, hydroinformatics, navigation and satellite imagery for emergency aid and humanitarian assistance

Even though many local ministries do not have adequate access to the Internet, use of the web for **dissemination of maps, services and geodata** is a major advance in delivering geographic baseline information for technical assistance in developing countries. Different **project services** (Map Shop, Webmapping and geodata download) can be accessed based on several geospatial databases for Sudan @ www.cde.unibe.ch/Tools/GIS_Sudan_TS.asp: Preprocessed topomap **download** in various file formats and resolution, **Web Feature Services (WFS)** for professional use in commercial and Open Source GIS environments, and **Web Map Services (WMS)** as the main source for desktop mapping in A3-A4 using the **CartoWeb** GIS application developer framework have been developed at CDE. Finally, **metadata catalogues like ESRI's GeoPortal** and **GeoNetwork OS** are excellent information sources for geodata searches and queries. As a result of web-links among local partners (i.e. www.gurtong.org, www.unsudanig.org, http://unosat.web.cern.ch) , map downloads have exceeded the figure of 150,000 in the last three years! As a backstopping and **communication platform,** the website has promoted the key element of cooperation and has provided excellent support in the area of technical assistance..

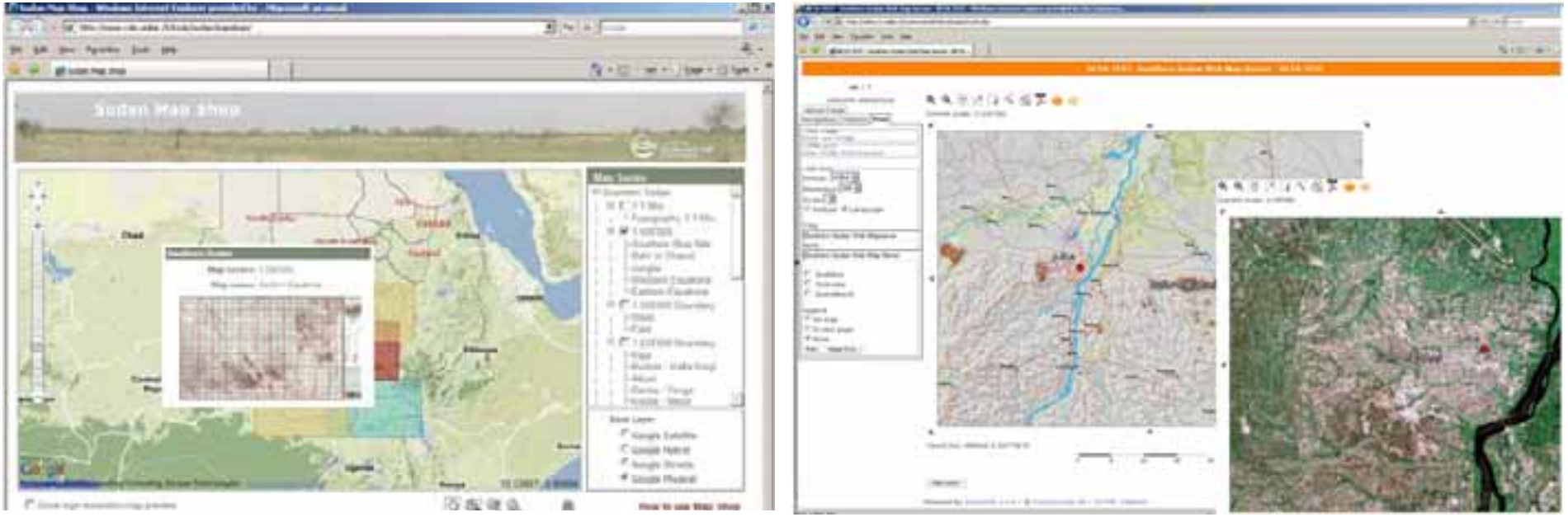

Figure 3&4: Map orders and map downloads are managed in the Map Shop (left); desktop mapping and geodata download (right) are supported by Webaps developed @ CDE.

REFERENCES

Proceedings

Gete Zeleke, Betre Alemu, Hergarten, Ch. and J. Krauer (2007): Cosultation Workshop on National Spatial Data Infrastructure and Ethio-GIS. Workshop Proceedings, Addis Abeba, Ethiopia. Centre for Development and Environment, University of Bern, Switzerland. Pp.69

Reports

Krauer, J. and Ch. Hergarten (2009): Capacity Development in Geoinformation Management. UN Agencies and the Government of Southern Sudan. Intermediate Reports for 2007 & 2008 SDC Switzerland

Krauer, J. (2007): GeoDB, Topographic Maps 1:500k, 1:250k and State Map Series Southern Sudan. Intermediate Reports 2004, 2005, 2006 SDC Switzerland