

## Experiences from Rwandan secondary schools using GIS

**Authors:** Martina Forster, Centre for GIS and Remote Sensing, National University of Rwanda; Théoneste Mutsindashyaka, Ministry of Education of Rwanda.

**Abstract:** The process of introducing GIS to secondary education of Rwanda runs parallel on various levels. Rwandan secondary schools participate in a GIS pilot project led by the Ministry of Education of Rwanda. 30 teachers of 10 pilot schools teach 500 students using GIS since January 2008 and evaluate the GIS textbook which was adapted specific to Rwanda. National educational institutions work concurrently on the development of a K12 curriculum and national standards for GIS, and design courses for future secondary school teachers. This paper presents the activities, the hurdles and progresses, and evaluates the first phase of introducing GIS into secondary education of Rwanda.

### A joint effort of the government, private industry and university

GIS and Remote Sensing technologies gain more and more a foothold in Rwanda, a post-conflict but fast recovery country. As part of Rwanda's national Vision 2020, focusing ICT and Education as major goals, the Centre for Geographic Information Systems and Remote Sensing of the National University of Rwanda (CGIS-NUR) supports the development of a GIS based education and research programs at the university. Alongside the mission of the university to serve the community, the centre is also seen as a consulting organ for GIS applications in governmental and private industry issues.

In 2005, ESRI Germany recognized the key role of the CGIS-NUR to support the use of GIS at all levels of the society and how it is working to transform Rwanda not only into an IT society but also into a "spatially" IT literate one. The centre won a Special Achievement in GIS award at the ESRI User Conference 2006 and brought the ESRI Presidents, Jack and Laura Dangermond, to Rwanda later in the year. The beauty of those famous Thousand Hills, each one occupied by thousands of children, gave the idea to Jack and Laura Dangermond to grant GIS software to every secondary school.

To ensure that GIS really gets started in secondary schools, ESRI Germany additionally sponsors a GIS specialist and teacher to the CGIS-NUR, who can help to bring GIS to the teachers and students. Finally, the CGIS-NUR together with the Ministry of Education initiated last year the introduction of GIS at Rwandan secondary schools.

The started "ArcGIS in Secondary Schools" project aims at capacity building for Rwanda's youth over all. The use of maps and graphics helps students to familiarize with computers;

and at the same time it fosters spatial reasoning and students gain a comprehensive understanding of their environment and its challenges in a fast changing world.



Figure 1: Rwanda – a thousand hills with fields of coffee, corn and banana trees.

## Introducing GIS in 10 pilot schools

In a first phase, 10 schools or 30 teachers respectively have been trained for teaching with GIS tools in the classroom. The schools and teachers have been selected according to different criteria, such as number of working computers, experience in teaching IT and stable electricity. The public, private and religious schools with French and/or English instruction are distributed all over the country and serve as training centres for subsequent schools in their close neighbourhood. Since January 2008 they teach GIS to about 500 students and evaluate GIS as a didactic media to explore, investigate and illustrate common curricula contents. For the reason that an official curriculum is missing, the teachers offer GIS lessons on a voluntary basis and rely on a draft GIS textbook<sup>1</sup> designed for Rwandan students/teachers: Basic GIS methods and tools (ArcGIS ArcView) are applied to environmental, societal and economic problems, imposing thus a multidisciplinary exploit of GIS.

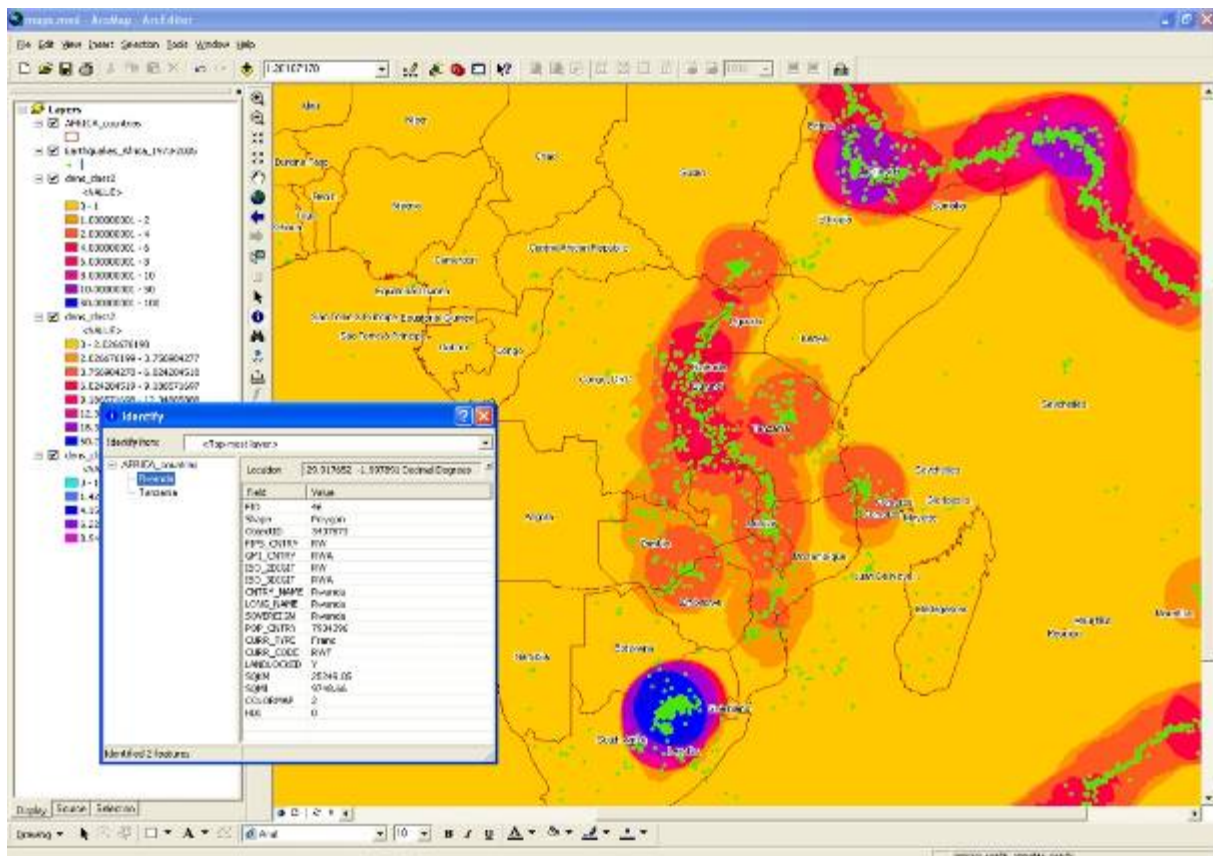


Figure 2: Calculation and visualisation of earthquake densities in the African Rift valley.

Through a snowball dispersion model, where schools train following schools and teachers support teachers, the project plans a yearly expansion by factor four. Started in 2007, it is the expectation to reach all 600 secondary schools of Rwanda in 2011. Continuous close assistance, evaluation and support are most crucial for the successful roll-out, as the move of new media into classrooms is challenging. And it is especially demanding at schools where traditional blackboard teaching is the only applied teaching method.

## Teachers' experiences

In Rwanda only a handful of secondary schools have 20 or more computers. Most are older machines that have been refurbished and donated. They have only little working memory and if internet is

<sup>1</sup>Treyer, R., C. Treuthard Bieri, M. Wüthrich; adapted by Martina Forster. 1<sup>st</sup> Rwandan Edition, 2008. *Geographic Information Systems (GIS) – Basics and Exercises for Secondary Education*. In press.

available it is predominantly too slow for efficient use in a lesson of fifty minutes. Some schools don't have electricity at all, or have frequent power outages. In addition to the infrastructure shortage, there are only few teachers who have had regular exposure to information technology.

In 2003 the Ministry of Education set up an ICT training program for secondary schools' teachers. Until now about 1000 teachers have completed these trainings and learnt how to write letters, email, calculate with tables, how to prepare presentations and they gathered basic knowledge in handling an access database. Meanwhile, only a few schools provide lessons in ICT, because the curriculum is not yet published and lessons are not budgeted.

The 10 GIS pilot schools, which started teaching GIS since January 2008, recently have been visited in order to evaluate the program and to help them with broken or formatted computers that required a new installation of the software. The results from these visits proved some expected difficulties, and on the other hand surprised with amazing developments at schools.

The frequency of teaching GIS varies from 1 to 2 lessons per week per class. All schools teach at least one senior 5 class (U.S. Grade 11; 40-50 students) and sometimes also senior 6 classes. Since they started teaching with GIS, students and teachers tell that they benefit in both, geographic understanding and computer skills. But the typical GIS lessons vary widely between theory instruction and practical exercises! One teacher tells, that in his GIS lessons he usually first demonstrates an exercise on his computer, and then the students explore it themselves in their own speed. The small groups of students that share together one computer are very supportive to weak students as they get prompt and close support directly by their stronger peers – who, by the way, can often explain better than the teacher as they use the same “language”. Actually, most teachers agree that if 2 students are using 1 computer, they benefit from each other and the teacher's support effort decreases remarkably.



Figure 3: One of the pilot schools' computer room. They have only 10 computers and if two or three fail, a whole ICT or GIS lesson possibly misses its objective.

However, from other schools we've learnt that after half a year almost no practical exercises have been done. They mostly lack sufficient working computers because of virus infection or other defects, and decide just to “demonstrate” GIS instead of letting the students use the small amount of computers that is working properly. One teacher says he's giving GIS lessons since the beginning of the year, but he doesn't use computers for a good – or rather appalling? – reason: Their working computers obviously are used in the school's internet café, which's

income is substantial to cover maintenance cost of the school computers. Another school encounters difficulties to gain frequent access to the computer lab because of a very restrictive administration. And one school recently hired a technical service that uninstalled all computer software, so that they were sitting and waiting until the GIS software was installed again.

Yet the rather unfortunate examples are compensated by astounding efforts at other schools. In order to combine the teachers' different skills, six of the ten schools found a work scheme where the GIS lessons are taught by two staff, one is the instructing teacher and one is the assistant who helps the students to work on the computers. These schools have one ICT teacher and two teachers from GIS relevant subjects that have been trained in GIS. As a result they combine their efforts and insert GIS lessons in their curricula as it fits. For example the Geography teacher introduces plate tectonics to the students and moves with the class to the computer lab for a lesson with GIS in order to visually explore and understand the relation between earthquake or volcano occurrence and the tectonic plate boundaries. The GIS lesson is then mainly held by the ICT teacher.

An impressive success story comes from two schools that started acquiring small GIS projects for their communities. They do their best to gain experiences through real GIS jobs and to improve the students' skills in this technical field. In Rwanda, there is still a lot of geographic data absent. This gives those schools a great opportunity to provide their "mapping service" to the local government or any other interested institutions.



Figure 4: Teachers in a GIS training at the GIS centre of the National University of Rwanda.

Overall, the teachers found they continuously improve their own skills through teaching GIS, and they judge GIS as a constructive teaching and learning method to both, students and teachers. Even if the initial work load demands a lot from the teachers and they allocate a lot of their private time to this undertaken, they believe it is very useful. They use the adapted GIS textbook as a teachers' guide. However, the recent evaluation shows that it is not yet helping the teachers at its optimum, but that a detailed

schedule for each lesson would be highly appreciated. Also, they suggest considering the formal integration of GIS into the curricula so that the use of this exciting tool is not stopped because of the teachers' high work load.

## Engaging the national education institutions

It is thus part of the project, that at the same time that the schools advance the GIS use in the classrooms, we pursue the integration of GIS also at the policy level of education. To secure the efforts being taken at the schools level, a first step towards institutionalisation has been launched with the National Curriculum Development Centre this year. Based on the evaluation of the textbook and the experiences at the pilot schools, a framework for GIS curricula has been developed (senior 1-6) and could serve as the basis for the elaboration of teacher guides in the form of detailed schedules. The proposed framework sees GIS as a new *teaching method* on one hand and as an own *subject or chapter* on the other hand. The adaptation and approval of a GIS curricula and respective national

standards is the objective of the next year(s) and is indeed necessary for future teacher education, high quality teaching and resource allocation for GIS lessons in Rwandan secondary schools.

Apart from the curriculum development, GIS education is slowly becoming part of the Ministry's bodies. Started through a pilot project together with the Ministry's ICT unit, first steps have been taken to incorporate GIS within the Teacher Service Commission who's coordinating the teacher education at primary and secondary level. Also, we hope to evaluate GIS use together with the Education Inspectorate soon. The involvement of such authorities still demands a lot of awareness rising activities, such as participation in education workshops and exhibitions, reports and news in local media or school events where students can demonstrate what they learnt.

Additional to the GIS use in schools, GIS advances within the planning and administration activities of the Ministry. The currently deployed Educational Management Information System (EMIS) incorporates spatial information and thus GIS. It is of high value for school planning to learn about the geographic locations of the ca. 3000 education facilities of the country, and to compare with other geographic information such as the electricity network, water supply, road access and census data. In order to benefit from such a complete information system, the Ministry envisions opening an operation centre, as a point of access to all kinds of information about education in Rwanda.

## Challenges to deal with

Bringing information technology to those hundreds of schools situated in the hilly countryside of Rwanda is not an easy undertaken. The government started improving the access to computers and IT services with the setup of Tele-Centres. Thanks to these centres, mobile phone charging, writing letters, scanning and copying of documents and other kinds of services get accessible to the rural community and shall familiarise the remote areas of Rwanda with ICT.

Although there are many efforts taken to facilitate the promotion of ICT in the country, the introduction of GIS in schools faces still some challenges. For many schools, the first question that comes up is the power supply for computers. Stable electricity is a hurdle for many schools that are far from the electricity network and pay high fuel prices to run a local generator. After that, the internet accessibility for communication between schools, the Ministry and education authorities, depends heavily on the schools' own efforts. When it comes to teaching with ICT, it would be most helpful if the schools had a classroom management software for improved teaching without projectors. Finally, the donated computers often arrive in a bad shape or require some installations before the schools can use them. As the teachers don't have the knowledge of maintaining computers, the computers will just wait in the corner until somebody assists the school in setting up the infrastructure.

IT support and maintenance of computers is then also a major challenge in general. In the case the schools encounter computer failure or when machines stop working because of virus infections, they miss a support manual on how to deal with the problem. At the GIS schools, the support needs have been divided into "minor support need" that can be solved by the ICT teacher, and "large support need" where support can only be provided by specialists. However, to prevent from failures and crashes, legal software copies and antivirus programmes are an urgent requirement. The set up of a maintenance and technical support solution for ICT at schools, as well as the establishment of a long term GIS position at the Ministry, are thus developments which are most desirable.

Further on, high quality of training for the next 90 GIS teachers is crucial. Only well trained teachers are self-confident enough and dare to apply GIS in the classroom. The provision of detailed lesson plans (schedules) is decisive for many teachers because it gives them some assurance.

Continuing the evaluation and supervision of the GIS use at the schools is very important to detect individual or overall challenges and solve them appropriately. After all, the project hopes to learn from the schools and tries to adopt the way how GIS can be used in the schools based on the teachers, students and headmasters opinions.

Finally, the knowledge transfer from the GIS specialists should not only happen towards schools, but also into the national education institutions. The CGIS-NUR started the introduction of GIS in schools

with all kinds of activities that were required. To ensure the take over from the efforts taken by CGIS-NUR, the relevant the local authorities and the Ministry get trained in GIS and will learn how GIS affects their daily workflows within planning and administration. We hope our enthusiasm for GIS can hence jump on these key institutions in order to continue our shared objective of GIS in secondary education.

## Expanding the knowledge – Conclusion

In this summer 2008 the project gets to the critical stage, where the trained GIS teachers will train the subsequent 90 teachers from 30 more schools. It is a critical stage in the meaning of the whole implementation plan of the project, which relies from now on heavily on the teachers' skills and efforts taken. If the next 90 teachers succeed in the quality control assessment in the end of the training and in the GIS exam in the end of the year, the roll-out of GIS has successfully started.

Introducing GIS to Rwandan secondary schools adopts Rwanda's general endeavour for becoming an IT centre of excellence. It is not only building capacity but is also creating future job fields for Rwanda's youth. Students and teachers gain computer skills and enlarge their knowledge in the field of modern computer technologies.

The National University of Rwanda benefits from the rising level of awareness when students enter higher education. Real support in the production of maps and data will relieve CGIS-NUR and allow for focusing more on research and study program development.

Counting on the fast-developing ICT sector in Rwanda, the future vision is to deploy modern GIS using ArcGIS Server technologies and ArcGIS Desktop ArcView. Students will be able to overlay national topographical data with locally collected data and to jointly exchange their data, results, and exercises to open up broader perspectives. This must not be limited to Rwandan schools; in fact, it is a larger goal to connect Rwandan students to students all over the world, synchronizing their expertise.

The project hopes to contribute to the creation of responsible citizens that care about the future of local communities backing the society.

## References

- Forster, M. 2008. *Teaching GIS at Rwandan Secondary Schools*. In: ArcNews, Spring 2008 Issue. <http://www.esri.com/news/arcnews/spring08articles/teaching-gis.html>.
- Forster, M., M.Schilling, T. McConnell. 2007. *Introducing GIS to K12 Education in Rwanda*. In: 2007 ESRI EdUC Proceedings. [http://gis2.esri.com/library/userconf/educ07/educ/papers/pap\\_2041.pdf](http://gis2.esri.com/library/userconf/educ07/educ/papers/pap_2041.pdf).
- Ministry of Education. 2008. <http://www.mineduc.gov.rw>. Last visited: 23 June 2008.
- Treyer, R., C. Treuthard Bieri, M. Wüthrich; adapted by Martina Forster. 1<sup>st</sup> Rwandan Edition, 2008. *Geographic Information Systems (GIS) – Basics and Exercises for Secondary Education*. In press.

## Author information

Martina Forster  
Centre for GIS and Remote Sensing  
National University of Rwanda  
Tel: +250 0840 3837  
Fax: +250 530 210  
[martina.forster@cgisnur.org](mailto:martina.forster@cgisnur.org)  
<http://www.cgisnur.org>

Théoneste Mutsindashyaka  
Ministry of Education of  
Rwanda  
Tel: +250 0831 2878  
Fax: +250 584 234  
[tmutsindashyaka@ineduc.gov.rw](mailto:tmutsindashyaka@ineduc.gov.rw)  
<http://www.mineduc.gov.rw>