Summary of the 2nd Energy Modelling Platform for Arica 2019 (EMP-A 2019) training

GIS- Based Electrification Planning and GIS Data and Software Management

University of Cape Town, Cape Town, South Africa

January 14-29th, 2019

Introduction

The second annual *Energy Modelling Platform for Africa 2019 (EMP-A 2019) training* was held under the capacity building component of the Global Program for *Geospatial Electrification Planning Scale Up* which is being implemented at the global level under the ESMAP Sustainable Energy for All Technical Assistance Facility (S-TAP), supporting client countries in achieving universal access to modern energy services by 2030. The 2-week intensive training was jointly organized by ESMAP, the World Bank, United Nations Economic Commission for Africa (UNECA), UNDP, UNDESA, DFID, University of Cape Town, KTH and the OpTIMUS Community.

Two training tracks was offered to cover two key aspects of sustainable electrification planning: modelling and data management. These tracks were designed to address the priority capacity gap identified with operational teams, and lessons learned from previous capacity building efforts.

Track 1 - Geospatial electrification modelling: provided an overview of basic concepts of geospatial analysis and the benefits of geospatial planning for the achievement of universal access as well as utility management and power sector planning. Subsequently, the students were introduced to different modelling tools (with a focus on modelling options with and without MV lines. These tools enable the identification of country-based investments financing requirements, integrating grid and off-grid solutions and the results in turn inform national electrification efforts. The first track mainly targeted energy planners and utility representatives.

Track 2 - Geospatial data and software management: provided training in the installation, design and management of a geospatial database, use of geospatial software, analytics, data collection and management for use across the energy sector. Participants were given an overview of open-source and proprietary desktop, mobile and cloud-based tools for managing and developing a sustainable electrification planning system. The second track targeted: energy planners, utility representatives and IT/ICT specialists, preferably with background in GIS.

Although the two tracks aimed to empower different practitioners, some sessions were jointly attended to ensure the adequate empowerment of the trainees.

During the last two days of the training, the attendees had the opportunity to present theirs results to the class and get feedback from representatives of the training partner institutions. This offered participants the opportunity to interact and exchange experiences from their respective fields and countries.

The two weeks of training were followed by a **high-level strategic meeting on January 30th and 31th**. Government officials, policy makers, representatives of international organizations and the modeling community of practice on energy planning discussed the challenges for a data driven approach for the achievement of the 2030 agenda. The high-level meetings were composed by 8 sessions: (i) setting the scene, (ii) investment outlooks, (iii) how partners are supporting the member states with energy modelling and planning, (iv) energy modelling capacity building in Africa, (v) donors capacity building activities and

improved coordination, (vi) case studies presentation by participants, (vii) electrification modelling in Africa, (viii) Capacity building with medium to long term systems models.

In addition, the high-level meeting included; a presentation from Rhonda Jordan (Energy Specialist WBG), Chris Sanders (TTL for Zambia), the pre-launch of the UNDP/UNDESA Guide to Models for Sustainable Development, the launch of the FEEM Book Energy in Africa & Renewable Energy and Sustainability in East Africa, the launch of the "Facebook: Free and Open Access MV data for electrification planning", and the presentation of the forthcoming Global Electrification Platform (GEP) from World Bank Group.

Figure 1: Photographs from the UCT Campus training

Background

The training had 23 participants in total; 15 were nominated by WB TTLs under World Bank projects. The participants were asked to anonymously evaluate the training after its completion, and 100 percent of the participants gave the training an overall rating of minimum 4 out of 5 (appendix I and II).

The first day of the training participants were given an overall introduction to the benefits of geospatial planning for electrification, the rationale behind the two different tracks and an overview of WB geospatial engagements. The last day of the training, Christopher Saunders (Senior Energy Specialist) and Chiara Rogate (Energy Specialist) provided a targeted overview of how geospatial plans inform electrification programs, investment costing, and support the identification of technical assistance and capacity building requirements. The presentations focused on the adoption of a comprehensive overview of electrification programs (grid, off-grid, capacity building) and sector-wide approaches.

Track 1 - GIS- Based Electrification Planning

The division of Energy Systems Analysis at the Royal Institute of Technology (KTH-dESA) based in Stockholm, Sweden was contracted for the organization and management of EMP-A as well as *Track 1 - GIS- Based Electrification Planning*. The training was conducted by two trainers under the leadership of Professor Mark Howells. The participants were introduced to and trained in the following tools:

- QGIS- free and open-source cross-platform desktop geographic information system (GIS) application that supports viewing, editing, and analysis of geospatial data;

- OnSSET - Open Source Spatial Electrification Tool (OnSSET) [1] - is a bottom-up optimization energy modelling tool that estimates, analyzes, and visualizes the most cost-effective electrification technology. The tool integrated the WB Tiers approach and was developed by KTH;
- Python (using Pycharm and Jupyter) - Python is an interpreted high-level programming language for general-purpose programming. Pycharm and Jupyter Notebook are Python Integrated Development Environment-IDEs, used for running and developing codes.

Starting by using a simplified web-based version of OnSSET, the participants gained sufficient knowledge to later develop their standalone country specific models. These models are in large extent based on openly available data that the participants collected during the first week. Some participants also incorporated **country specific data that they collected domestically**. Despite the limited time, the participants managed to develop rather sophisticated models, providing important insights, that are great starting points for further development. The models developed and all tools (mentioned above) are open, customizable, and fully transferable for further use after the completion of the training.

Track 2 - GIS Data and Software Management

The second track *GIS Data and Software Management* was conducted by Kartoza in the lead of Tim Sutton, together with Gavin Fleming and Admire Nyakudya. Kartoza are Free and Open Source GIS (FOSSGIS) service providers, providing a global service to individuals, companies and governments around the world who are looking to leverage the power of the Free Software movement to solve geospatial problems. They have a proven track record in precision agriculture, disaster risk reduction, biodiversity information systems and many more.

This track provided training in the use of geospatial software, analytics, data collection, and management for use across the energy sector – an introduction to a Spatial Data Infrastructure (SDI). Participants were trained in open-source, cloud-based, and proprietary tools for managing and developing a sustainable electrification planning system.

At the start of the course the attendees were introduced to the concepts *of Open Source, Open Data* and *Open Standards*. These three value propositions remained key concepts throughout the course. The course program was planned to cover three main topic areas:

1. Geospatial databases (based on PostgreSQL and PostGIS)
2. Geospatial data manipulation including management, visualization, creation, editing, analysis and development of cartographic products (based on QGIS)
3. Spatial Data Infrastructures

During the workshop sessions, overarching tasks were assigned to the participants which covered inter alia:

- Collaboratively developing a simple data schema for electricity grids

[1] OnSSET considers spatially explicit characteristics related to energy. Such data include population density and distribution, proximity to transmission and road network, nighttime lights, local renewable energy potential etc. OnSSET focuses on the assessment and deployment of conventional and renewable energy technologies aiming at ensuring access to affordable, reliable, sustainable and modern energy for all.

- Implementing that schema both as GeoPackage and then as PostGIS tables
- Working in a multi-user environment, connecting to remote databases and editing
- remote datasets
- A 'data hunt' - discovering and downloading GIS data from the internet and then
- importing it into our PostGIS based sandbox platform
- Producing a GIS project that incorporates diverse data sources in an organized
- manner
- Creating meaningful and clear cartographic styles for GIS data
- Developing print ready products
- Uploading and downloading GIS data from a cloud platform as part of an SDI
- (demonstrated with GeoNode)
- Developing an analysis protocol to solve real-world problems, including using and
- processing very large datasets
- Developing a presentation based on their analysis results
- Mobile mapping

One aspect of the course program that was not initially planned, but that the participants showed an interest in **was mobile data collection**. Because of this the program was adapted to include a run through of key mobile mapping technologies and how the data collected in the field can be incorporated into the data management platform.

The mobile data collection exercise step by step (Figure 2):

1. Walking around UCT campus geo-tagging locations of interest
2. Collecting the data in the open source app 'Epicollect 5' (available for both IOS and Android) and adding the location using the mobile device GPS, adding a photograph and a written description
3. Back in the lecture room, the participants downloaded the geo-referenced locations to their computers.

Figure 2: The mobile data collection exercise

Presentations

To ensure that the trainees from track 1: (i) saw the application of the models in the real world and (ii) learned how to present the benefits of geospatial modelling to relevant stakeholders to inform policy making and sector investments, the participants were asked to give presentations on the outputs of their country models the last day of the training. Similarly, the trainees from the second track was asked to summarize and present their key learnings. The trainees received feedback from a panel consisting of Holger Rogner (OpTIMUS), Mark Howells (KTH), Linus Mofor (UNECA) and Chiara Rogate (ESMAP), Chris Saunders (WBG) and Nicolina Lindblad (ESMAP). In addition to the presentations, they were also asked to compile a poster with the key messages and take away from the training.

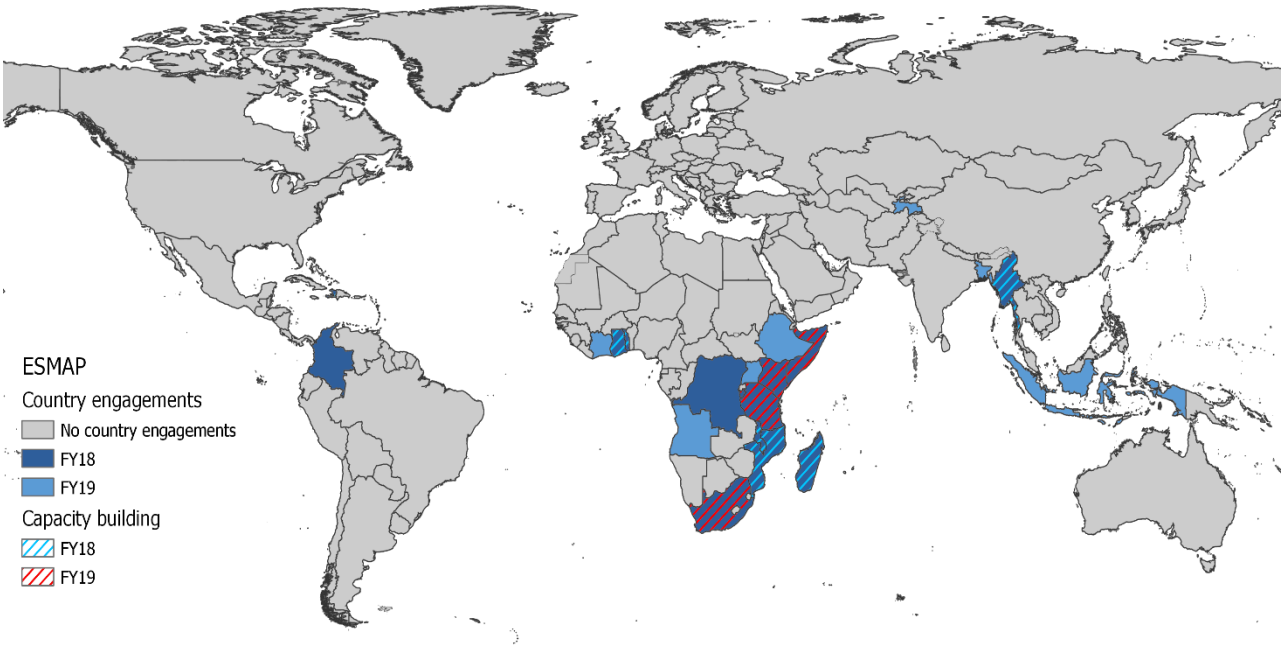
This exercise was also meant, on one hand, to test the internalization of technical skills, and on the other, to communicate complexity and knowledge in a simplified way. Each team received tailored feedback from either WB or other seasoned stakeholders in the field of geospatial planning and client engagement to improve trainees' ability to present and disseminate the benefits of a data driven approach to electrification planning in their respective institutions. These skills will also be key to support WB engagements under the *Geospatial Electrification Planning in the Africa Region* multi-country project.

Figure 3: Photographs from the two tracks including presentations.

Geographic coverage

The countries in red (hashed) in Figure 4. indicates the countries that received training in Cape Town and the countries in turquoise (hashed) the previous regional capacity building effort in Trieste, Italy in June 2018. This is overlaid with ESMAP country engagements for FY18 and FY19 (dark and light blue respectively).

Figure 4: Country engagements and regional capacity building efforts under ESMAP



Future capacity building engagements

To inform future capacity building activities conducted under the *Geospatial Electrification Planning Scale Up*, based on the feedback from participants, trainers, and through dialogue with operations the following recommendations have been made:

- **The two tracks were proven successful** both in terms of prior demand and ex-post feedback, this indicates that these are still relevant to our clients.
- **Continued collaboration with operations** to assure that the trainings are tailored to address the need of the country engagements. Through this dialogue **distribution infrastructure digitization** has been identified as a missing component and due to its importance for successful electrification planning it is strongly advisable to be incorporated in future efforts. *It has now been included in the capacity building activities (starting in Trieste, 2019).*
- **Open source-based software** has been strongly promoted and should continue to be a preferred option, as well as the emphasize on 'key concepts' over specific software. This does not only promote sustainability it also enables the communication and continued assistance through online platforms and communities highly associated most opensource software;
- **Joint sessions for overlapping topics** - The combined sessions between the two tracks was very highly successful. This did not only transfer concrete knowledge between the two tracks, but perhaps more importantly this enabled the participants to gain and deeper understanding in the importance of both components for successful electrification planning.
- **Right participants.** Having the right background skillset in the room is key for the success of the capacity building activities and to ensure a similar pace and empowerment.
- **Female participation** is low;
- **'Training of Trainers'.** Will start being purposed to exponentially increase the impact of the capacity building activities conducted and the breadth of client country professionals understanding the benefits of GIS planning. *This has been reflected in the curriculum for the next training in Trieste, June 2019.*
- **Rewarding proficient participants with official diplomas** – trainings could also be organized to vertically increase the skillset of participants. A system of diplomas could also be set in place under the OpTIMUS community of practice.
- **GIS gap analysis in count countries.** Through requesting participants to come to the training with an overview of the GIS and other key information for planning) available in the country. This would increase the efficiency of WB engagements. *This has been reflected in the curriculum for the next training in Trieste, June 2019.*
- **E-learning material** should be further explored for pre-training and intermediate training;
- **A "Going home package"** could be provided to the participants after completion of the training with a structured list of materials storing the information provided during the training.

Appendix I – Feedback track 1: Electrification modelling training

After the completion of the training the participants were asked to fill in a feedback questioner, some results can be found below.

Table 2: Results questioner

	1 (low)	2	3	4	5 (high)
Overall rating of the training	-	-	-	-	100%
Overall rating of the trainers	-	-	-	33%	66%
If a similar training would be offered in the future, how willing would you be to attend?	-	-	-	-	100%

Table 3: Results questioner

	Very Likely	Likely	Not likely	
How likely are you to continue using QGIS after this workshop?	100 %	-	-	
How likely are you to continue using the OnSSET tool after this workshop?	100 %	-	-	
	Very good	**Good**	**Not so good**	**Bad**
How would you rate the overall structure of the training?	67 %	33 %	-	-
How would you rate OnSSET in terms of providing useful insights for electrification processes in your country?	33 %	67 %	-	-
How would you rate the instructors?	67 %	33 %	-	-
	Yes	**No**		
Would you recommend this training to others?	100 %	-		

Table 4: Results questioner

	Too fast	Fast	Good	Slow	Too slow
How would you rate the pace of the training?	33 %	-	-	66 %	-

What is the key experience/knowledge that you have gained from the training?

- To calculate LCOE by using formula and OnSSET
- Ease of Electrification Planning/Modelling using Online data and open source Tools
- I learned about the existence of modern tools used in electrical planning

Are there any requests that you feel is necessary to be included in the next version of the tool?

- Could incorporate more lower voltage Power line layers (66kV, 33kV & 11kV) and to allow an option of Modelling based on Household Structures instead of population data sets. Include more technologies for evaluation. I shall provide more suggestion so as to make the process more realistic.

Appendix II – Feedback track 2: GIS Data and Software Management

After the completion of the training the participants were asked to fill in a feedback questioner, all results can be found below.

Table 5: Results questioner

	1 (lowest)	2	3	4	5 (highest)
Overall rating of the training	-	-	-	86%	14%
Overall rating of the trainers	-	-	-	57%	43%
If a similar training would be offered in the future, how willing would you be to attend?	-	-	-	14%	86%

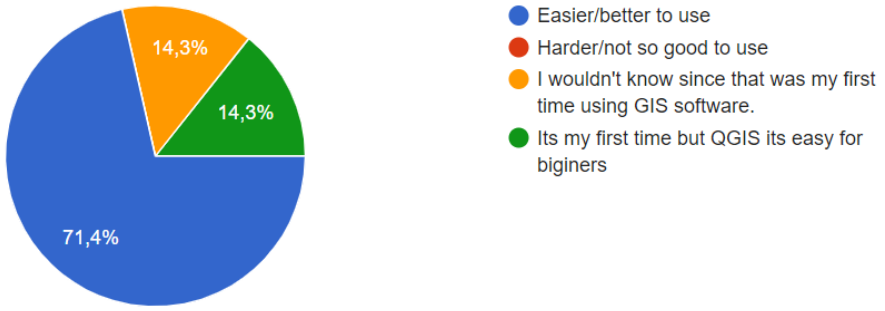


Figure 5: How would you rate QGIS in comparison with other GIS software that you have used/seen before (e.g. ArcGIS, Manifold etc.)?

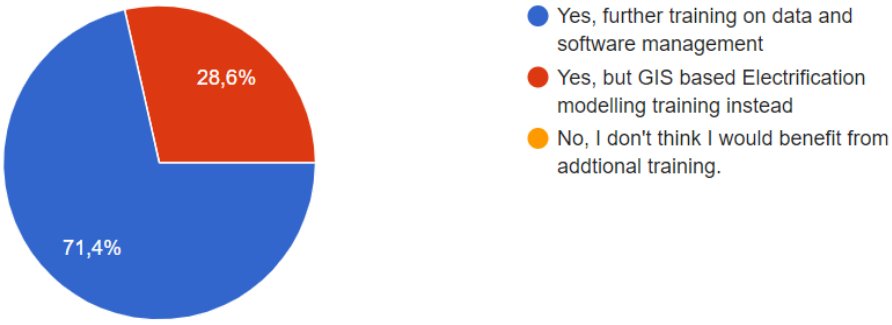


Figure 6: Would you like to participate in future trainings either on the same topic or the other track (GIS based Electrification modelling training) ?

Table 6: Results questioner

	Improved a lot	Improved a little	Did not improve	
Comparing with your expertise before the workshop, how much did your knowledge improve in terms of general use of GIS data and processing?	100%	-	-	
Geospatial databases (based on PostgreSQL and PostGIS)	57%	43%	-	
Geospatial data manipulation including management, visualization, creation, editing, analysis and development of cartographic products (based on QGIS)	86%	14%	-	
Spatial Data Infrastructures	57%	43	-	
Importance of sessions	**Very Useful**	**Useful**	**Indifferent**	**Not useful**
Collaboratively developing a simple data schema for electricity grids	43%	43%	14%	-
Implementing that schema both as GeoPackage and then as PostGIS tables	71%	29%	-	-
Working in a multi-user environment, connecting to remote databases and editing remote datasets	57%	43%	-	-
A 'data hunt' - discovering and downloading GIS data from the internet and then importing it into our PostGIS based sandbox platform	57%	43%	-	-
Producing a GIS project that incorporates diverse data sources in an organized manner	71%	29%	-	-
Creating meaningful and clear cartographic styles for GIS data	71%	29%	-	-
Developing print ready products and/or presentations	71%	29%	-	-
Uploading and downloading GIS data from a cloud platform as part of an SDI(demonstrated with GeoNode)	71%	14%	14%	
Developing an analysis protocol to solve real-world problems, including using and processing very large datasets	43%	57%	-	-
Mobile mapping	71%	29%	-	-
	Very good	**Good**	**Not so good**	
How would you rate the overall structure of the training?	57%	43%	-	
How would you rate the training material (documents, presentations etc.) in terms of content, quality and clarity?	86%	14%	-	
How would you rate the instructors?	71%	29%	-	
	Yes	**No**		
Would you recommend this training to others?	100%	-		

Table 7: Results questioner

	Too fast	Fast	Good	Slow	Too slow
How would you rate the pace of the training?		57%	43%		-

Which aspects of GIS were most relevant for your work? Were there any important processes important for electrification activities that were not used/shown?

- Being introduced to use QGIS, at the moment I have QGIS installed in my PC to play more with it to try and introduce it to the other colleagues as well
- Geospatial Modelling and Database Management.
- As far as I know most important aspects of GIS were shown regarding the day today activities in our electrification activities.
- Digitize of grid network and analysis
- Database Management. The trainers covered most of the areas I was interested in.
- Yes, it is very important, and it shown the exactly activities that i am working.
- Aspects that have been of great interest to me are related to the basic use of data to replicate layers and generate maps that are exploitable. Almost every important process for planning electrification has been presented.

Do you have any additional feedback on GIS material/training?

- The material was spot on, I am planning to use it or explore it more at my own time.
- I think it was very helpful. Might need more time to master certain aspects in future.
- The material was general, but it was better to have some materials of case studies for grid networks or electrifications.
- It was an eye opener especially on the use of open source software, QGIS.
- Provide website and register for getting news and update
- My comment is that it is necessary to program another training session especially on the subject related to the collection of field data and produce related layers in order to generate maps and not consult the database of others. Concrete examples would seem very important.

What is the key experience/knowledge that you have gained from the training?

- Learning or hear about how other countries, also the way they use the software or store their data it was fascinating.
- Geo-Spatial analytics and application as well as team building and collaborations.
- How to use QGIS to make different electrification analysis.
- To much starting QGIS, POSTGIS data bases, geosnode and geoserver, SDI, grid infrastructure using GQIS.
- GIS Data management especially when data is coming from different organizations.
- Electrification analysis
- Frankly it was very interesting for me to understand how maps are produced from database collected on the ground. Sometimes I found georeferenced maps with explanations in study reports but now I am able to make a necessary interpretation myself and I am able to use QGIS software for scenarios in order to try to propose solutions to the problem that has arisen."

Please feel free to add any additional comment (what is your overall impression? areas for improvements? or something else)

- Next time if it is possible the hours per day can be shortened a bit, they were a bit long:
- It was very good to share and fulfill the experience and would recommend additional participants within the next installment of the event.

- Dinner some days were not good, but the overall the training was so good and the knowledge of the track I received I will used in our daily activities as am the one who given responsibility of GIS matter in my organization.
- Need more training
- In general, I appreciate the training and ask to think again to those who have benefited from training for other training in the energy sector and especially for the recent themes followed for capacity building.