Summary of the 3rd Summer School on Modelling for Sustainable Development (SDSS 2019)

Geospatial Electrification Modelling and Geospatial Data and Software Management

International Centre for Theoretical Physics, Trieste, Italy

June 10th-2th, 2019

Introduction

The third annual *Summer School on Modelling for Sustainable Development (SDSS 2019)* was held under the capacity building component of the Global Program for Geospatial Electrification Planning Scale Up, which is being implemented through 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 3-week intensive training was jointly organized by ESMAP, the World Bank, United Nations Development Programme (UNDP), United Nations Department of Economic and Social Affairs (UNDESA), UK Department for International Development (DFID), Abdus Salam International Centre for Theoretical Physics (ICTP), Royal Institute of Technology (KTH) and the OpTIMUS Community.

The Summer School consisted of two training tracks that were offered from June 10th to 26th to cover key aspects of sustainable electrification planning; two focus groups about the Global Electrification Platform on June 26th; and a High-Level (HL) meeting with geospatial electrification modeling practitioners and stakeholders on June 27th-28th. A commitment between the WB and ICTP to host this training annually for the next three years, up to 2022, was announced at a reception to mark the end of the summer school and the beginning of the HL meeting.

The two training tracks - geospatial electrification modelling and geospatial data and software management - were designed to address the capacity gaps identified by World Bank Group operational teams and lessons learned from previous capacity building efforts. The second track was introduced for the first time during the previous training in Cape Town (January 2019) and, for the first time, training for the digitization of the MV network was offered in Trieste. The following is a summary of the two tracks offered at the summer school.

Geospatial electrification modelling (GEM): 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-specific investment 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.

Geospatial data and software management (GDSM): provided training in many aspects of geospatial data management and analysis, design and management of a geospatial database, use of geospatial software, analytics, data collection and management for use across the energy sector and beyond. Participants were given an overview of open-source and proprietary desktop, mobile and cloud-based tools for MV lines mapping, 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.
The HL meeting involved 44 participants, while the two training tracks had 21 participants in total, of which 13 were nominated by Task Team Leaders (WB TTLs) under World Bank projects.

Background

During FY18 and FY19 almost 20 countries in Sub Saharan African (SSA) participated in regional training efforts hosted by the S-TAP initiative under ESMAP. This accounts for about 40 % of all SSA countries. Beyond SSA, participants from Tunisia, Haiti and Myanmar also received training. Figure 1 indicates the countries that successfully received training during FY19 in turquoise and FY18 in hashed.

Figure 1: Regional capacity building efforts under ESMAP during FY 2018 and FY 2019

Track 1: Geospatial Electrification Modelling (GEM)

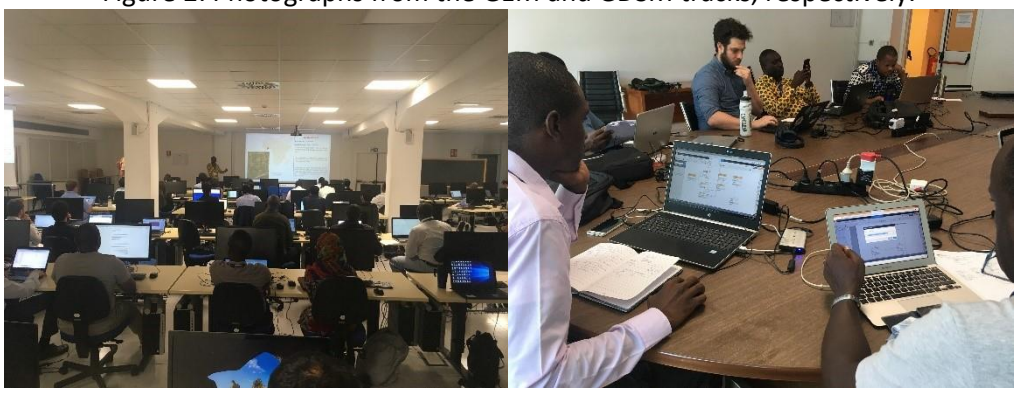
The division of Energy Systems Analysis at the Royal Institute of Technology (KTH-dESA) based in Stockholm, Sweden was contracted for the organization and management of the Sustainable Development Summer School (SDSS) as well as for lecturing and performing training track Geospatial electrification modelling. The training was conducted by two trainers under the leadership of Professor Mark Howells. The participants were introduced to and trained in the following:

- Spatial data collection, cleaning, processing and visualization in QGIS. QGIS is an open-source geographic information system (GIS) software.
- Geospatial electrification modelling using the Open Source Spatial Electrification Tool1 (OnSSET). OnSSET is a bottom-up optimization energy modelling tool that estimates, analyzes, and visualizes the most cost-effective electrification technology for a targeted region.

- Basic python operations 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.
- The Global Electrification Platform (GEP), an open access, interactive, online platform that allows overview of electrification investment scenarios for a selection of countries.

Starting by using a simplified web-based version of OnSSET, the participants gained knowledge to 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 had acquired in their home countries**. Despite the limited time, all participants managed to develop OnSSET models for their countries and explore electrification pathways for achieving their national energy access targets. These results informed short, policy-oriented presentations aiming to kick off further discussion. All tools, datasets and models developed in the course of the two weeks are open, customizable, and fully transferable for further use after the completion of the training.

Figure 2: Photographs from the GEM and GDSM tracks, respectively.



Track 2: Geospatial Data and Software Management (GDSM)

The second track *GIS Data and Software Management* was conducted by Kartoza led by Tim Sutton and Gavin Fleming. This track provided training in the use of geospatial software, analytics, data collection, spatial data infrastructure (SDI), and management for use across the energy sector. The attendees were also trained in MV line mapping skills, such as the collection of field data using open-source android app mobile devices, the capturing of electrical infrastructure data, and data treatment for the modeling of electrical networks. In other words, the training aimed to demonstrate to the trainees the data management lifecycle, move the data from field data collection to the desktop to our geospatial database.

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

3. Mobile data collection (based on Input and QGIS) focused on MV line mapping.

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

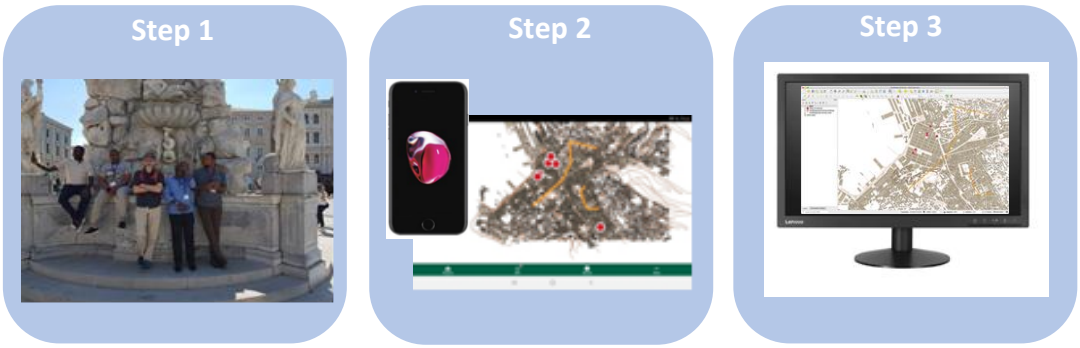
- Collaboratively developing a data schema for energy planning projects;
- Implementing that schema in PostGIS;
- Working in a multi-user environment, connecting to remote databases and editing remote datasets;
- A 'data hunt' - discovering and downloading GIS data from the internet and then importing it into PostGIS;
- 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 a 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;
- A mobile mapping and data collection exercise focused on MV line mapping. The exercise was constituted by the following steps (Figure 3):

  Step 1: Walking around Trieste geo-tagging locations of interest with the mobile phone;

  Step 2: Collecting the data in the open source app 'Input' (available for Android) and adding the location using the mobile device GPS, adding a photograph and a written description;

  Step 3: Back in the lecture room, the participants downloaded the geo-referenced locations to their computers in order to clean, validate and manage the data for the modeling of electrical networks.

Figure 3: The mobile data collection exercise



Joint Sessions

During summer school, there were joint sessions attended by both tracks with the aim of showing the interconnections between the geospatial tools and how they are inserted in real electrification planning, as well as promoting knowledge sharing among the trainees.

The first joint session took place at the beginning of the summer school and it was dedicated to introducing basic geospatial concepts and the contents of each track. Additionally, a second

session presented to the trainees three key WB platforms for energy planning: **Energydata.info, Global Wind Atlas & Global Solar Atlas.**

In addition, the Summer School hosted 3 classes taught by the main vendors and tool developers in the geospatial planning field:

- Columbia University: Professor Vijay Modi made a videoconference with an overview of GIS planning tools for electrification on Wednesday, June 19th;
- NRECA: Nicholas Allen made a videoconference about the NRECA's model for geospatial platform development and electrification analysis on Thursday, June 20th;
- Comillas University & MIT: Professor Fernando de Quadra Deep presented the Reference Electrification Model – REM developed by the Universal Energy Access Lab, a partnership between MIT and Comillas University on Wednesday, June 26th.

Interactive Learning

To ensure that the trainees (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 on the last two days of 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 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.

The presentations were evaluated by Holger Rogner (OpTIMUS), Mark Howells (KTH), and Francesco Fuso Nerini (KTH).

Focus Groups (June 26th)

There were two **focus groups about the open source interoperable Global Electrification Platform (GEP)**, one focused on possible technical advances (interoperability, data and model sharing) and another on outreach activities (annual outlooks and country engagement). The ESMAP team and KTH presented the GEP for feedback to: IRENA, IAEA, UNDESA, DFID, MIT, and trainees from the Ministry of Energy of Uruguay, Uganda, Eswatini and Ghana. Following the focus group, IRENA, UNDESA and IAEA expressed interest in improving coordination of capacity building activities to avoid duplication of efforts and to improve the identification of planning gaps in client countries. Additionally, they expressed interest to participate in the consultation on the establishment of data standards under the GEP and ensure adequate data sharing through **Energydata.info**. The potential establishment of a partnership under the GEP, which would be publicly disclosed with the visualization of the organizations' logos on the website, is under consideration, and follow-up discussions on all the above-mentioned dimensions are ongoing.

High-level Meeting (June 27th-28th)

The two weeks of training were followed by High-Level (HL) meetings on June 27th-28th. These meetings were organized to discuss progress made to date and the way forward to best support the incorporation of quantitative methods into national decision-making processes for sustainable development. Government officials, policy makers, representatives of international organizations and the modeling community of practice on energy planning were invited to discuss the achievement of the 2030 Agenda for Sustainable Development. Please see Appendix I for the list of participants.

The HL meetings discussed the use of data driven modelling tools to inform national sustainable development policies. They were organized in five sessions: (i) Communities, tools, co-creation and capacity building, (ii) Global Modelling and regional investment needs for Sustainable Development, (iii) Improving the efficacy sustainable development planning and partnerships, (iv) Outcomes of the 2019 Summer School: Selected presentations from participants, (v) Providing analysis and evidence in support of sustainable development policies. The ESMAP team presented the Global Electrification Platform (GEP) and received positive feedback.

Finally, the HL meetings were closed with a strategic discussion on the transfer of appropriate, effective and transferable tools to client countries. The discussed topics were: (i) Real world relevance and academic excellence of open toolkits and methods: Developing a global curriculum; (ii) Participant Reflection: what needs to be improved during the trainings; (iii) Donor, organizer and UN Reflection: how to make efforts sustainable; (iv) An environment that enables a community of practitioners for evidence-based policy making.

A complementary event as part of the International Round Table Initiative on Strategic Energy Planning was held in the afternoon of June 28th following the HL meeting. It was organized by the Energy and Economic Growth (EEG) program, funded by the UK Department for International Development (DFID) and aimed to endorse the "Key Principles of Energy for Energy Planning".

Recommendations for future capacity building engagements

To inform future capacity building activities conducted under the Geospatial Electrification Planning Scale Up, feedback was solicited from participants. The trainees were asked to anonymously evaluate the training after its completion, and all the respondents gave the training an overall rating of at least 4 out of 5 (the results from the evaluation are found in Appendix I and II). The participants also reinforced the quality of the trainers and materials, as well as the importance of an open source-based software for the academia. However, they emphasized that the compilation of national GIS datasets is still a problem.

With feedback from participants and trainers, and through dialogue with WB operations teams, 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, the training for digitization of grid network infrastructure (MV mapping) was added to the second track. The

success of the exercise signals the demand for this capacity building and it will be retained for the next Summer Schools.

- **Open source-based software** has been strongly promoted and should continue to be a preferred option, and the training should emphasize key concepts rather than training in specific pieces of software. This promotes sustainability as the tool users are trained with are free and open, and the concepts they learn are applicable across numerous applications.
- **Right participants -** Having the right background skillset is key for the success of the capacity building activities and to ensure similar pace and empowerment.
- **Female participation is low**, so that some instruments were identified to encourage the female participation, such as full scholarships for women, remote or short-term training options, providing childcare at the training or funding for that in the countries, family rooms and flights for children. DIFD also expressed interest in supporting gender balance, which translated into a broader conversation on how to improve gender balance in energy planning and of women in STEM. A follow-up conversation on the topic was organized with Inka Shomer to identify further options of collaboration on the subject between DFID and ESMAP.
- **'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.
- **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.
- **E-learning material** should be further explored for pre-training and intermediate training.
- **Creating a portal for questions** before and after the 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.
- **Beginning a collaborative dataset** with information of each country used in the last training tracks in order to help on the countries data compilation in the next summer school.
- **Some weekend recreational activities**, including city tours and/or a visit to a near energy company, should be planned for the upcoming summer schools. Trainees indicated that the agenda for the two weeks was too intense involving also homework over the weekend.

Appendix I – Feedback for Geospatial Electrification Modelling

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

Table 1: Overall questionnaire

	1 (low)	2	3	4	5 (high)
Overall rating of the Training	-	-	-	20%	80%
Overall rating of the Trainers	-	-	-	-	100%
Overall rating of te Training facilities at ICTP	-	-	-	-	100%
Overall rating of the accommodation at the ICTP	-	-	-	75%	25%
Overall rating of the food at ICTP	-	-	20%	80%	-
If a similar training would be offered in the future, how willing would you be to attend?	-	-	-	-	100%

Table 2: Expertise Growth

Learning Outcome	Remained the same	Improved a little	Improved a lot
Comparing with your expertise before the workshop, how much did your knowledge improve in terms of general use of GIS data and processing?	-	20%	80%
Your understanding of basic GIS concepts	-	20%	80%
Yout understanding of GIS data types (vectors and rasters)	-	50%	50%
Your understanding of how to generate and collect my own GIS data (e.g. georeference or download form the internet)	-	80%	20%
Your knowledge on energy access and the sustainable development goals	20%	20%	60%
Your understanding of the results and insights that can be gained from a geospatial electrification model	-	-	100%
Your understanding of the role of geospatial data in the electrification process	-	25%	75%
Your understanding of the processes necessary to generate my own electrification scenario using the GEP Scenario Generator	-	-	100%
Your understanding of what type of GIS data I need to conduct my electrification analysis	-	-	100%
Your understanding of sensitivity analysis, scenarios and their usefulness	20%	-	80%
Your understanding on how to clearly represent my results	-	20%	80%

Table 3: Pace of the training

	Too fast	Fast	Good	Slow	Too slow
How would you rate the pace of the training?	-	60%	40%	-	-

Table 4: About GEP Explorer

		No	Yes
Did you know about the GEP Explorer before the workshop?		80%	20%
Would you recommend the GEP Explorer to others?		-	100%
	Useful, further work is necessary to assess in what degree	**Useful**	**Very Useful**
How useful is the GEP explorer platform in your work?	20%	20%	60%
	Yes, further work is necessary to assess in what degree	**Yes, to a small degree**	**Yes, to high degree**
Can the results from the GEP Explorer be used to inform electrification policy?	20%	20%	60%

What additional elements would you have in the GEP Explorer in order to make the results more comprehensive/useful?

- It requires to have some information from Data Management and OSeMOSYS courses;
- The GEP explorer should provide at least 50% effect on the existing infrastructure;
- Show graphically the proposed network extension.

What aspect of electrification are critical and missing from this platform?

- Impact of the forecasted demand/supply on the existing network;
- More detailed modelling options for off-grid technologies;
- More details by region of a given territory.

The participant Nickson Kasolo expressed the wish that someone from the KTH / WBG team present the GEP at the Energy Sector GIS workshop in Kampala, around September 2019.

Table 5: About GEP Scenario Generator

	Not likely	**Likely**	**Very likely**
How likely are you to continue using QGIS after this workshop?	-	-	100%
How likely are you to continue using the GEP Scenario Generator - OnSSET tool after this workshop?	-	-	100%
	Regular	**Good**	**Very Good**
How would you rate GEP Scenario Generator - OnSSET in terms of providing useful insights for electrification processes in your country?	-	40%	60%
		No	**Yes**
Would you recommend the GEP Scenario Generator - OnSSET tool to others?		-	100%

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

- Reducing the processing time for large areas;
- Making easer to load the variables;
- Incorporating more options for off-grid modelling solutions;
- Visualizing the new network generated in the scenario in the results;
- Making the interface more user-friendly, especially in relation to results and graphs – for example: less texts, inclusion of the current year, possibility of visualizing/choosing years between the beginning and the end of the analysis period, and lastly, the coding must be hidden to avoid that in some cases this is accidentally adulterated.

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

- To use geospatial datasets for electrification planning;
- Existence of modern and open source tools for electrification planning;
- Importance of modelling tools to make better policy recommendations.

Appendix II – Feedback for Geospatial Data and Software Management (GDSM)

After the completion of the training the trainees were asked to fill in a feedback questioner, some results can be found below. All seven trainees completed the questionnaire.

Table 6: General thoughts on the training

	Not likely	Likely	Very likely
How likely are you to continue using QGIS after this workshop?	-	14%	86%
How likely are you to continue using PostGIS after this workshop?	-	29%	71%
	Not so good	**Good**	**Very Good**
Please rate the overall structure of the training (formal instruction combined with workshops)	-	14%	86%
How would you rate the training material (documents, presentations etc.) in terms of content, quality and clarity?	-	29%	71%
	Not so much	**Yes**	**Yes, Very Much**
Did you enjoy working on a personal project during the training?	-	-	100%
Were the objectives of the personal project clear?	-	14%	86%
	Not so good	**Good**	**Very good**
How would you rate the instructors?	-	-	100%

Table 7: Expertise Growth

	Did not improve	Improved a little	Improved a lot
How much did your knowledge of Geospatial databases (based on PostgreSQL and PostGIS) improve?	-	29%	71%
How much did your knowledge of Geospatial data manipulation including management, visualization, creation, editing, analysis and development of cartographic products (based on QGIS) improve?	-	29%	71%
How much did your knowledge of spatial data infrastructures (SDI's) improve?	-	43%	57%

Table 8: Importance of sessions

Sessions	Not Useful	Little Useful	Useful	Very Useful
Collaboratively developing a simple data schema for electricity grids	-	-	29%	71%
Designing a database model	-	-	29%	71%
Implementing a database mode from a design	-	-	29%	71%
Working in a multi-user environment, connecting to remote databases and editing remote datasets	-	-	43%	57%
Data hunting - discovering and downloading GIS data from the internet and then importing it into our PostGIS based sandbox platform	-	-	-	100%
Producing a GIS project that incorporates diverse data sources in an organized manner	-	-	14%	86%
Creating meaningful and clear cartographic styles for GIS data	-	14%	-	86%
Developing print ready products and/or presentations	-	14%	14%	71%
Uploading and downloading GIS data from a cloud platform as part of an SDI (demonstrated with GeoNode)	-	-	14%	86%
Developing an analysis model to solve real-world problems, including using and processing very large datasets	-	-	-	100%
Mobile mapping	-	14%	-	86%

Table 9: Importance of joint sessions

Joint Sessions	Not so Interesting and relevant	Interesting and relevant	Very interesting and relevant
Overview of GIS planning for electrification - Columbia University	-	43%	57%
NRECA's geospatial/engineering model - Nicholas Allen	-	29%	71%
Deep electrification planning: the REM-RNM models - Fernando de Quadra - Comillas & MIT	-	43%	57%

Table 10: Overall Questionnaire

	5(Lowest)	4	3	2	1 (Highest)
Overall rating of the training:	-	-	-	43%	57%
Overall rating of the trainers	-	-	-	29%	71%
What did you think of the venue ICTP and Trieste?	-	14%	14%	43%	29%

Figure 4: About the upcoming trainings