Capacity Development and Collaboration for Sustainable African Agriculture: Amplification of Impact Through Hackathons

PRACTICE PAPER

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ABSTRACT

The paper describes the concept of INSPIRE Kampala virtual hackathons, with the main focus to build and strengthen relationships between several European Union (EU) projects and African communities that started in 2019 with the Nairobi INSPIRE Hackathon. The main focus is exploring a new model for capacity building based on virtual hackathons as an excellent opportunity for bringing together people from different work environments, culture and disciplinary backgrounds. This paper is describing experience and lessons learned from the Kampala INSPIRE Hackathon. INSPIRE Hackathons have evolved over a five year period since it started and during this period we developed a model of fully virtual Hackathons, which we recognise as optimal for Africa. The paper describes all stages of Hackathon building: definition of themes, selection of mentors, development, webinars as tools for sharing experience, final presentation, selection of winners and awarding ceremony. As important we consider also planning other actions, because we don't see INSPIRE Hackathon as an event, but as a continuous process. Demonstration part of paper describes the lessons learnt from the winning challenge: Desert Locus Monitoring. The description of all phases demonstrate Kampala INSPIRE Hackathon approach. On the basis of experience we defined strategy for the future, how to continue and successfully extend such a model in Africa.

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1. INTRODUCTION

Open Earth Observation and open geo-spatial Information are critical technologies to supporting and achieving the 2030 United Nations (UN) Sustainable Development Goal (SDG) agenda, including SDG2 on 'Zero Hunger'. The Research Data Alliance (RDA) Capacity Development in Agriculture Data Working Group (WG) aims to develop synergies between science, education and training, and development practice. This includes sharing knowledge (ideas) on training initiatives and technologies, and reducing digital divide to ensure that researchers and practitioners from developing countries can also benefit from the practices evolving from developed countries. The Kampala INSPIRE ideathon and hackathon is a good example of capacity development in agriculture data.

Hackathons are an excellent opportunity for bringing together people from different work environments, culture and disciplinary backgrounds (***Figures 4, 5*** and ***6***), forming teams around a problem or idea, learning from peers and teams, and collaboratively co-creating unique solutions to address modern challenges cannot be addressed better. Traditionally organised as on-site events, with teams working on different challenges judged on predetermined parameters, hackathon events are considered more productive than their virtual counterparts. However, they are also expensive to run, host and participate in, which can exclude many potential participants. Virtual hackathons are therefore preferred as a good way of promoting inclusiveness and digital participative collaboration; to share knowledge, enhance learning, and to implement emerging practices.

The goal of the Kampala INSPIRE Hackathon 2020 was to build on and strengthen the existing partnerships between several EU projects and African communities.

2. BACKGROUND OF INSPIRE HACKATHONS AND IDEATHONS

The word hackathon was created by a combination of the words "hack" and "marathon" and traditionally hackathons are organized as on-site events with different groups working on different challenges that are judged on diverse pre-agreed parameters (Kollwitz & Dinter 2019). The concept of the INSPIRE hackathon differs from traditional hackathons in that it is not just a multi-day event, but it is a continuous process designed to effectively use results from previous hackathons. This means that challenges are defined to build on the results of previous hackathons with the aim of enriching the previous innovation actions. INSPIRE hackathons last for several months as virtual events.

The full virtual INSPIRE Hackathons provide an excellent opportunity for bringing together people from different work, cultural, and disciplinary backgrounds (***Figures 4, 5*** and ***6***). Teams are formed around predefined challenges to explore and apply scientific achievements, share knowledge, develop capacity and collaboratively evolve answers to the predefined challenges. The outputs from the INSPIRE Hackathons generally take shape as: websites, webinars, applications, tools, policy papers, or processes.

The first INSPIRE hackathon was organized as part of the INSPIRE conference in Barcelona 2016 (Charvat et al. 2018). The INSPIRE hackathon concept therefore evolved as a means of supporting sustainability and implementation of results of the European Commission Research Framework Program FP7 and H2020 (Bye et al. 2018a), (Bye et al. 2017). The initial idea mainly focused on the sustainability of Open Land Use datasets, Smart Point of Interest, and Open Transport Map[1] coming from SDI4Apps,[2] Open Transport Net[3] and FOODIE[4] projects. In cooperation with citizens observatories projects CITI-SENSE,[5] CobWeb,[6] Ground Truth 2.0,[7] LandSense,[8] the concept of combination Voluntary Geographic Data Initiatives was built (Harris et al. 2013), (Charvat et al.

1 *https://www.plan4all.eu/open-data/*.

2 *https://sdi4apps.eu/*.

3 *https://cordis.europa.eu/project/id/620533*.

4 *http://www.foodie-project.eu/*.

5 *http://www.citi-sense.eu/*.

6 *https://cordis.europa.eu/project/id/308513*.

7 *https://gt20.eu/*.

8 *https://cordis.europa.eu/project/id/689812*.

2011), (Charvat et al. 2013) and citizens observatories (Higgins et al. 2016). This brought together different project communities to facilitate transfer of technology, and knowledge, between the projects, and eventually to organizations, and companies. Acknowledging that sustainability of communities is pivotal to these transfers, the idea of a series of hackathons became part of the INSPIRE hackathon concept right from the start; nourishing, and gradually building a multi actor and multi disciplinary community that embraces non-formal learning dimensions. The INSPIRE hackathon is therefore not an event, but a process. An important component of the Infrastructure for Spatial Information in Europe (INSPIRE) directive is to make data, and information, interoperable, which is the central point of the INSPIRE ethos, and 'inspired' the INSPIRE hackathon concept (SCAR 2019). Although the 2016 hackathon was all on-site, bringing problem solving and idea development together, the combination of online and on-site activities were simultaneously implemented. As the community expanded both within Europe and beyond, the need for remote working as an addition to in-person events became apparent. It is for this reason that the Plan4all association decided to organize virtual INSPIRE hackathons which started in 2017.

Over fifteen INSPIRE Hackathons have been organized since 2016 by the Plan4All association.[9] The network of supporters, co-organisers, and active participants has steadily grown. Open data and open source, interoperability, support for Copernicus, INSPIRE and Group on Earth Observation) GEO remain the common themes of the virtual events, in spite of variations in expertise, perspectives, and technical abilities which change with the times and global trends. The Hackathons themselves spark many interesting ideas, with results from one event often forming the basis for changes in the next hackathon fashioning. INSPIRE events are open to everyone interested in participating and serve as a platform for international expert collaboration, training, and capacity building (Bye et al. 2018b).

3. METHODOLOGY FOR THE KAMPALA INSPIRE HACKATHON

The goal of the 2020 Kampala INSPIRE Hackathon was to continue building and strengthening existing partnership between various EU projects and African communities that began with the 2019 in the Nairobi INSPIRE Hackathon (Nairobi INSPIRE Hackathon 2019). The Nairobi INSPIRE hackathon attracted more than 200 participants representing 26 African countries. It concluded with an explicit demand for a follow-up in the Kampala INSPIRE hackathon, where African mentors, supporters, and participants were included.

The methodology of the Kampala INSPIRE Hackathon was built on the general INSPIRE hackathon concept (***Figure 1***). Normally the online/virtual hackathon ends with a concluding event and presentation ceremony. The Nairobi INSPIRE Hackathon ended as part of the IST-Africa conference in Africa. The incidence of COVID-19 global epidemic, unfortunately precipitated the Kampala INSPIRE hackathon resulting in the event being organised for the first time as a fully virtual event (Kampala INSPIRE Hackathon 2020).

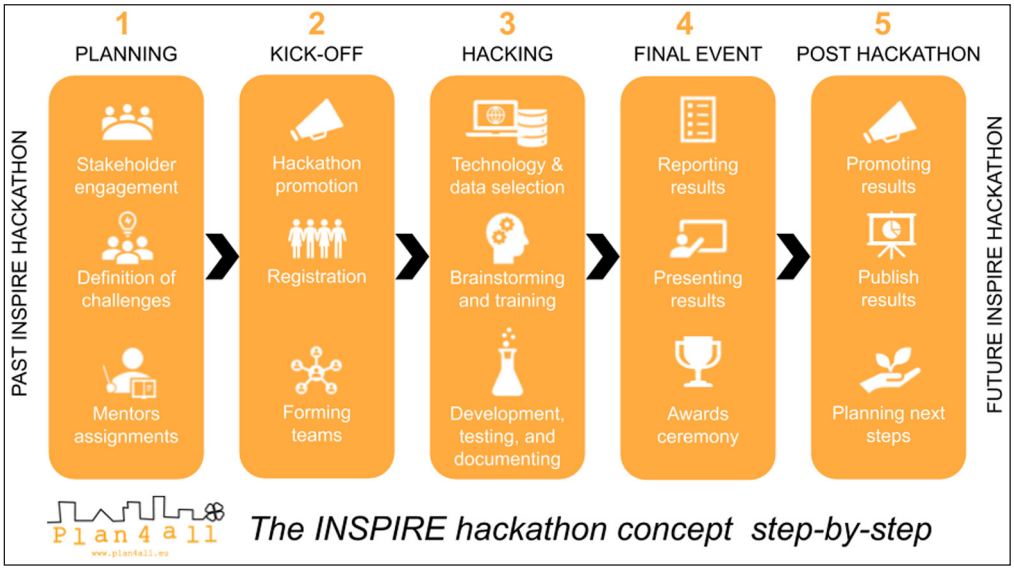

Figure 1 The general concept of the INSPIRE Hackathon: Showing how events feed into each other as part of an ongoing process that defines the INSPIRE concept.

9 *www.plan4all.eu*.

The Kampala INSPIRE hackathon started in March 2020 and concluded with an online event on Wednesday 6 May, 2020, bringing together over 200 participants from over 40 countries (***Figure 4***). Participants represented 42 countries world wide: Africa 20 countries (77% of registrants), Europe 12 countries (12% of registrants) and 11 other countries (11% of registrants) Multidisciplinary teams (***Figures 5*** and ***6***) were formed, addressing a total of 10 challenges. The themes covered included agriculture, food security, desert locust, citizen science, climate change, and ethics.

3.1. HACKATHON THEMES AND CHALLENGES

As earlier indicated, INSPIRE Hackathons are initiated with predefined themes, from which challenges are identified and evolved. The main theme of the Kampala INSPIRE Hackathon was ***Sustainable Africa***. The key topics therefore were: agriculture, environmental sustainability, collaborative open innovation, and ICT-enabled entrepreneurship. Ten challenges were identified for the Kampala INSPIRE Hackathon. Chapter 4 of example represents the "**Desert Locust**" challenge which the hackathon addressed.

3.2. MENTORS

In the INSPIRE hackathons the Mentors guide teams that address pre-defined challenges. The Mentors' role in the INSPIRE Hackathon is critical as they coordinate the work of the teams, promote intra-team communication, facilitate knowledge transfer, coordinate the presentations dedicated to their team's results, make sure the results are presented at the final virtual event of the hackathon, support and attend the final virtual event. Based on the experience from a series of INSPIRE hackathons we have recognized the need of Mentors to secure progress of teamwork. Engaging Mentors strengthens and builds the community, creating ownership of both the event and the results. After the Nairobi INSPIRE hackathon the conclusion was that increasing the number of African Mentors drawn from GODAN (Global Open Data on Agriculture and Nutrition) National Champions at the South-South Country level could lead to more African participation in the teams.

3.3. WEBINARS

The purpose of organising webinars as part of the INSPIRE Hackathon is manifold. The webinar's main role is to activate and engage participants, providing an accessible communication channel (with the recorded chat enabled and used further as a communication tool between participants). The webinars are also educational, and contribute to building and development of capacity for both individuals and institutions (Capacity Development for Agricultural Data WG 2020). Webinars also help recruit more participants to the events and community.

3.4. HACKING

The Kampala Hackathon provided a good opportunity for participants with different backgrounds (e.g. researchers, farmers, entrepreneurs, developers) to select one or more of ten challenges that fitted both their interest, skills and knowledge.

Each team served as a forum for open discussion where the participants engaged in dialogue around their choice topics to: address the challenges, highlight the use and importance of technology, and promoted exchange of experiences and ideas resulting in knowledge exchange. Frequent communication between the Mentor and his/her team was facilitated through diverse communication channels. The working platforms and discussion channels were mainly Google Drive combined with MS Word, email groups, Skype or Whatsapp groups. The choice of tools were flexible and tailored to each individual group facilitating effective cooperation.

Training and lessons learnt from previous projects were provided by the mentors to the participants. The participants on their part shared their concerns, outcomes from their daily experiences. These interactions resulted in the outcomes as discussion notes and teamwork reports which were documented as the final report from each team presented at the end of the hackathon.

3.5. AWARDS

For participants, the main benefit of the INSPIRE hackathon is the opportunity to access and become a member of an international knowledge community of practice. INSPIRE hackathon participants receive a diploma documenting and acknowledging their active participation.

The top three jury-selected teams, based on a set of predetermined criteria, are offered the opportunity to contribute to peer-reviewed articles and citable publications documenting the outcomes and results of the events. It is hoped that this lasting legacy projects their career growth pathways. In the case of the 2020 Kampala INSPIRE Hackathon, teams were invited to publish their final reports as documents on the GODAN f1000 open publishing gateway for the benefit of the wider community (Plan4all et al. 2020).

3.6. PRACTICE-ORIENTED NON-FORMAL LEARNING AND CO-CREATION PATTERN

The hackathon and each challenge team forms a unique intellectual knowledge hub and social space that leverages the pattern (***Figure 2***) in a creative manner on searching solutions for real-life challenges. Team members' experiences and know-how, whether based on scientific research or practical work, is shared and exploited for non-formal group- and peer learning. Capacity development fosters the co-creation to find solutions that lead to emerging practices to advance agriculture (Ssembajwe et al. 2020), (Löytty 2020), (Charvat et al. 2019), (University of Washington 2020).

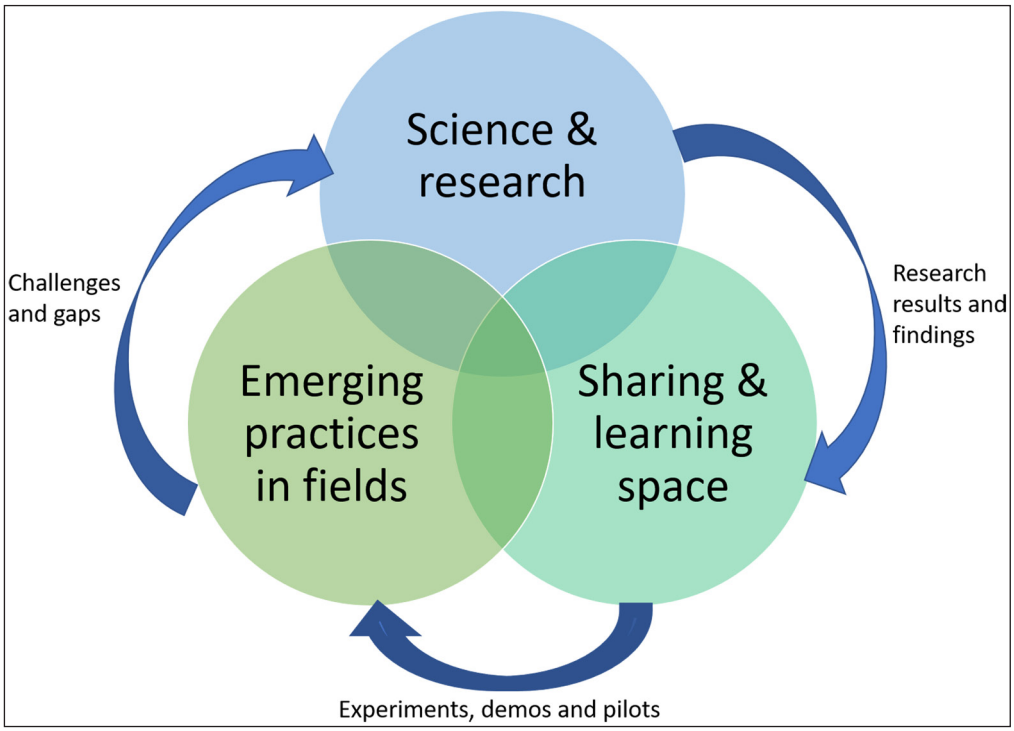

Figure 2 Practice-oriented learning and co-creation pattern.

4. A CONCRETE EXAMPLE: THE DESERT LOCUST ENVIRONMENTAL CHALLENGE

The hackathon team's work flows in 4 phases: 1) Prepare, 2) Ideate and build, 3) Test and learn, and 4) Finalize. The full report in (Cherenet et al. 2020).

1. Prepare: The predefined challenge statement gives the direction to the team's work. The Desert Locust teams' purpose is to find solutions and emerging practices on the challenge that is defined as follows: *"Parts of Eastern Africa are experiencing locust infestation since the end of 2019. It has posed a great threat to the East African Societies, with locust swarms comprising billions of locusts that damage crops and pasture. Without timely or effective interventions, sporadic cases of desert locusts can easily turn into an upsurge and ultimately a plague."* (Kampala INSPIRE Hackathon 2020). The preparation phase includes the team forming procedures, setting up the communication channels and defining roles and responsibilities of team members.

2. Ideate and build: In this phase, the team briefs on the challenge they seek to address, observes and analyzes the current state, explores available technology solutions, picks up the best option, and eventually builds the solution that responds to the challenge. As the team members learn

from each other, share knowledge, build capacity by exploring research results and novel technologies, they also learn how to co-create and ideate novel breakthrough solutions.

The team further develops a geospatial base risk outbreak model for the timely prediction of desert locust invasions. This solution applies Earth Observation data and machine learning methods for identifying areas most affected by locust invasion. The mapping tool covers Uganda, Kenya, Ethiopia, Somalia, Yemen, Iran and Pakistan (***Figure 3***).

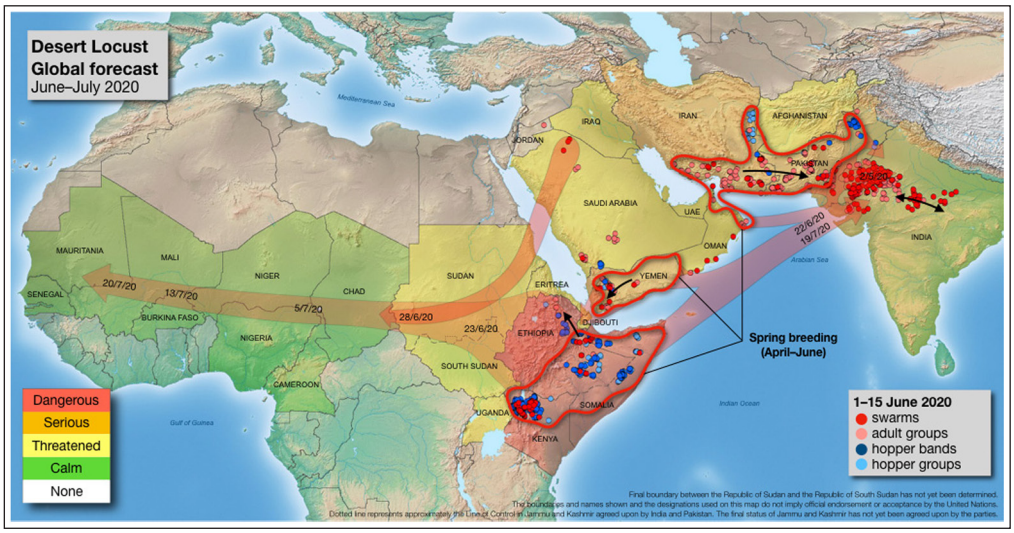

Figure 3 Desert locust watch, the situation on the 15th of June 2020.

Building the mapping tool the main tasks are data collection, data pre-processing and performing analysis using machine learning methods. The objective of this hackathon was to develop a structured workflow, entirely automatized that could be used by anybody to analyze the evolution of vegetation in specific regions that could be impacted by desert locust swarms. As the team was made of experts coming from different fields, there was a desire to build a product that could be easily understood yet also include technical innovations. The team consisted of participants with technical background in remote sensing, spatial data analysis, and machine learning, as well with a background in natural science. With this team composition, ideas were evolved in various ways ending up with the most comprehensive response to address the desert locust crisis. The composition of the team allowed extensive exchange of knowledge and opened new horizons and ideas on how to identify the complexity of the desert locust crisis in Africa.

3. Lessons learned: The post-test reflection of results of the entire work brought forward new ideas e.g. the possibility to automate, and by modifying some specific parameters that are identified as a bias in the training, improve the output.

Throughout the entire hackathon, the Desert Locust team kept learning and developing new skills and know-how about data set preparation, machine learning methods, Big Data management, handling and information retrieval, skills on virtual communication and accessing open databases, all of which are useful for accomplishing the challenge.

While geospatial solutions have great potential for transforming agriculture in Africa, it was evident that the realisation of the benefits of GIS (Geographic Information System) in Africa is still distant due to the challenges of data quality and availability of softwares, user application and knowledge, and the relatively low resolution of the currently accessible open-source geospatial data. Moreover, in Africa, geospatial data in many government institutions are available in analogue format rather than digital, hence making key challenges over the use of these technologies at the required quality and pace.

4. LESSONS LEARNED

The INSPIRE hackathons, Nairobi (2019) and Kampala (2020), provided a research framework for hackathon participants: organisers, mentors, team members and webinar participants, to reflect on each step of Hackathon concept (***Figure 1***). The framework presents an opportunity

to assess the inputs, methods and results to identify best practices and opportunities for improvements, and give feedback to the organisers. The following chapter describes the lessons learned from two hackathons.

PREPARATION STAGE OF THE HACKATHON

The INSPIRE Hackathon is a continuous process aimed at inter alia maintaining the collaboration established in the previous hackathons. As the Kampala INSPIRE Hackathon was not the first hackathon organized for the African continent, the previous experiences made it easier to connect to African community through the previous Nairobi INSPIRE Hackathon participants and co-organizers (e.g. Afrialliance, Food and Agriculture Organisation). It was also possible to use the GODAN Presence in Africa through its South-South Secretariat in Nairobi and its Programme for CApacity Development in Africa. These local contacts helped to better target the topics related to current African needs and define the challenges related to agriculture, environmental sustainability, collaborative open innovation, Earth Observation Systems, and ICT-enabled entrepreneurship. At the same time, some of the previous Nairobi hackathon participants became Mentors for the Kampala INSPIRE hackathon. Their experience in being participants in the Nairobi INSPIRE hackathon brought the added value for their current role as Mentors while at the same time remaining an open community avoiding the risk of becoming a closed echo-chamber.

WEBINARS

An important part of the hackathon, especially when it is organized as a fully virtual event, were the webinar series and online training. During the one-month lasting webinar series (1st April–30th April 2020) more than 100 participants (of the total of 200) registered for the hackathon. The 11 educational webinars attracted over 1000 registrants for the webinars, as part of the Hackathon output. This showed that the INSPIRE hackathon creates a significant interest for learners with willingness to acquire new knowledge even beyond the hackathon participants. This proves that webinars are in addition to their educational value, a powerful instrument for capacity building, and outreach. It also became clear to GODAN that it is a viable avenue of reaching out to its National Open Data Champions. Besides webinars dedicated directly to the hackathon topics, participants were also encouraged to take the opportunity to take part in the webinars organized in the frame of hackathon co-organizing H2020 projects and organizations (e.g. EO4Agri, WeObserve, NextGEOSS projects and GODAN National Open Data Champions) and thus webinars expanded participants' access to knowledge and networking. The webinars also provided a space for discussion and sharing knowledge between disciplines and countries that helped the work of the teams move forward.

INSPIRE HACKATHON CONCEPT

Information technology like internet, zoom, skype, and google doc based information sharing proved useful to undertake virtual meetings, especially during the situation where you do not have an option to meet physically, particularly during the pandemic (COVID-19) period. During the whole period of the hackathon, especially through the webinar series, participants acquired different expertise and knowledge about a variety of data sources and data sourcing dimensions. These new skills and knowledge will be very important for the participants' future careers. One of the most important lessons learnt was on communication. What was lost in communication capacity such as not being able to use and read body language which was a necessary lesson learned on the need to be well prepared for the virtual meetings (e.g. read more carefully scientific articles, reviews, code (machine learning), online tutorials etc).

Participants from all teams assembled to share final results as well as in celebrating their achievements in an Online Awards Ceremony. This was a three hour event, where the results of each project were shared with other participants. Despite the unexpected barriers created by COVID-19, the research interest in African agriculture from practitioners, and stakeholders was prominent (***Figures 5*** and ***6***).

The INSPIRE hackathon participants consider non-formal learning and open innovation to be value adding. The social space of the teams are open to all nationalities, disciplines, and experiences that give diverse input such as non-formal peer- and group learning and co-creation. In addition, the progress is facilitated by the team mentors, stakeholders and open webinars.

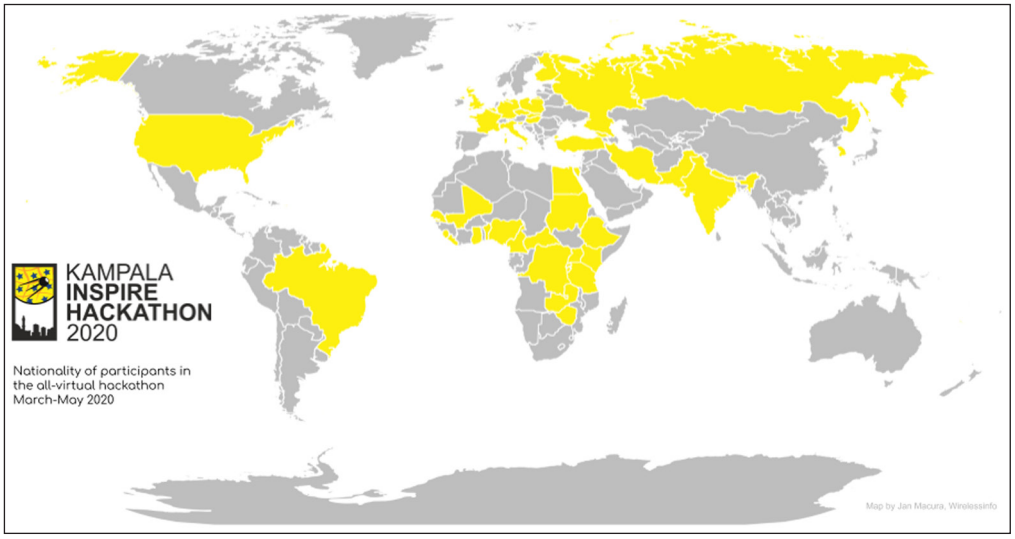

Figure 4 Nationality of participants in the all-virtual hackathon March–May 2020.

Figure 5 The expertise of the participants.

Figure 6 The disciplinary background of the participants.

5. CONCLUSIONS AND FUTURE WORK

African agriculture needs to be smart and sustainable. This requires a large effort towards building capacity in Africa. To guarantee real transition of African Farming Sector to Smart Farming, it is not only possible to transfer solutions and experiences from other parts to Africa, but it is necessary to involve African researchers and developers to the process and support their active role. As one from the possibilities of how to support capacita and development in Africa we see common work of researchers and developers from Africa with researchers and developers from other parts of the world. We see common work as the best way and one of the potential models are virtual Hackathons. This can help together with new emerging technologies.

The emerging technologies that include earth observation solutions, sensor based systems, and mobility device interfaces that are driven by Artificial Intelligence (AI) and Machine Learning (ML) are heavily dependent on the high-speed internet for communication and data storage. The internet also comes with the evolution of new knowledge that impacts all the corners of the world. The whirl speed digital evolution delivers new experiences to create synergies between science, education and training, and development practice, among all the actors.

Before the onset of COVID-19 Pandemic, on-site Hackathon events presented opportunities for teams to work on different challenges against which they were judged on predetermined parameters. Hackathons have been associated with fast paced programmatic experiences and are an excellent approach for bringing together people from different work environments, culture and disciplinary backgrounds so that they can form teams around a problem or idea. 'Hackathoners' have always found opportunity to learn from peer teams, and collaboratively co-create unique solutions to address the many challenges that face the world today.The INSPIRE Virtual Hackathon is not just a multi-day event. It is a continuous co-creation process designed to effectively use results from previous hackathons to build enriching solutions to existing or foreseen challenges. The INSPIRE hackathons last several months as virtual events interspaced with practice after engagements.

The hackathon and each of its challenges forms an unique intellectual knowledge hub and social space that leverages scientific results, non-formal learning and co-creation patterns (***Figure 2***) to new knowledge and practices and concrete technical results (e.g. Desert Locust). The team members from diverse science and practice, domains and many countries share knowledge, train each other and seek solutions to advance African agriculture and to prevent hunger.

The social space was also used to draw some conclusions across the hackathon's challenges, on commonalities and differences between the existing codes of conduct, guidelines, and regulations. It made it possible to extract and recommend the essential aspects and points for a general, scalable and further customizable code of conduct template that best addresses the farmers' needs and their empowerment with more equitable data flows while taking into account the relevant national laws and regulations.

An international community addressing smart agriculture and Earth observations with strong African participation has been further enhanced by the Kampala INSPIRE Hackathon, ready to be continued both in future hackathons and in other follow-up projects for example RDA (Research Data Alliance), GEO (Group on Earth Observation), EC (European Commission) and more.

The observations and improvements are taken into account in the forthcoming INSPIRE hackathon in Africa to enhance teams work to achieve concrete and sustainable results.

The Plan4all strategy is to continue and strengthen the cooperation with e.g GODAN, RCMRD (Regional Centre for Mapping of Resources of Development), AfriGEO, FAO (Food and Agriculture Organisation), IST Africa (Information, Science and Technologies- Africa monitoring ICT initiatives and research capacity) and extend it to other research and innovation actions on smart agriculture.

From two years experience we can conclude

1. Use of past research benefits the identification of challenges that new hackathons should focus on
2. Mentorship is critical to support hackathons through non-formal experiential learning
3. Learners benefit from dimensions of hanuman centered design thinking more so with co-creation in collaborative cross-challenge delivery of emerging practices, tools, insights and outcomes
4. Virtual hackathons are effective when well-designed for meaningful engagement to address challenges, mentors, capacity building and for supporting others as partners co-creators.

With organising these two hackathons we do not want to finish. We define some type of task or roadmaps for future:

1. Realizing the foregoing calls for localized frameworks to reach new hackathons and a pool of Mentors. GODAN's National Open Data Champion Consortia can help achieve this

2. Co-creation calls for cross knowledge needs across the value chain, an organizational dimension as the P4CDA's South-South FarmHub agenda makes SME driven agribusiness a necessary paradigm that Hackathons can measure impact from. Creating the FarmHubs as appendages of the Hackathon is not just necessary, it is important
3. Linkage with governments, development partners, research and academia is important for the sustainability of the Hackathons, there is need to promote the ESA Sentinel-driven linkage of the Earth Observation Solutions to support the Data Analytics and Innovation Centers to promote satellite based data sourcing

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

Karel Charvat is the initiator of Plan4All INSPIRE Hackathons. Bente Lilja Bye is the organizer and co-developer of INSPIRE Hackathons. Hana Kubickova is the coordinator of INSPIRE Hackathons. Foteini Zampati was the mentor of challenge 9 on ethical and legal aspects of open data affecting farmers and contributor to sections on lessons learnt and conclusion. Kiringai Kamau is the Africa Lead for GODAN and responsible for African content and team membership mobilization for INSPIRE Hackathon. Suchith Anand was one of the judging panel members of the Kampala INSPIRE Hackathon and contributed to the capacity development activities of the Hackathon and to this paper. Paul Kasoma, Maximilien Houë, Elias Cherenet, and Kizito Odhiambo were the mentors of challenge 4 and contributors to case – Locust Desert. Tuula Löytty was the mentor at INSPIRE Hackathon, Akaninyene Obot, Felix Kariuki, Antoine Kantiza, Ronald Ssembajwe, Samuel Njogo were the participants of INSPIRE Hackathon Kampala.

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