iSQAPER
Interactive Soil Quality Assessment

Deliverable 8.3. Short report on applying the soil quality tool to different policy challenges and settings: SQAPP for policy makers

Authors: Thorfinn Stainforth, Luuk Fleskens, Stephen Meredith

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Project Scientific Coordinator	Dr. L. Fleskens
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Author	T. Stainforth, L. Fleskens, & S. Meredith
Author email	tstainforth@ieep.eu
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1. Introduction to the App

The Soil Quality App (SQAPP) is the flagship deliverable of the EU-Horizon 2020 iSQAPER project. The SQAPP was designed with the idea that it should provide the user with the opportunity to access fragmented data on soil quality and soil threats in an easy-to-use way. Moreover, the user should not only receive indicator values, but be guided in interpreting these values by providing more contextual information: is a certain indicator value high or low in a given context. The system is set up to use soil quality and soil threat indicators for which spatial data exist as a first estimation for soil quality parameters in a given location, but these values can be replaced with more accurate own data by the app user. Ultimately, the user receives, based on an assessment of the most critical issues, management recommendations on how soil quality can be improved and soil threats be overcome.

This app may be of interest and have a number of possible applications for policy makers, elaborated in more detail in the following sections. In general, the most interesting aspects of the app for policy makers are the option to have bidirectional exchange of soil data with farmers and land users, and the relative quality and soil threat information the app provides, allowing to plan priority interventions.

Contextual information is provided through analysing indicators within 2098 pedoclimatic zones build up from all relevant combinations of climate zones (n=29) and soil types (n=118), and by distinguishing between arable land and grazing land. The comparative aspect of the soil indicator data is then realized by calculating cumulative probability density functions for each pedo-climatic zone. All indicator values are given as 'best guestimate' for the location. The user can, after specifying some details on crops grown and pest management applied, proceed with generating management recommendations based on these standard values, or replace some or all indicator values with own data to get more accurate recommendations. This design helps to make the SQAPP directly helpful by visualizing available soil information in a systematic and easy-to-access way.

Thirdly, the SQAPP recommends agricultural management practices to improve soil quality and/or mitigate soil threats based on an integrated assessment of the aspects most urgently needing attention. This integrated way of considering soil quality indicators is new in comparison to existing soil apps and indicator systems. This integration avoids consideration of poor single indicator scores in isolation, which could have trade-offs with other soil quality indicators that are also suboptimal.

Fourthly, although the iSQAPER project focuses on Europe and China, it quickly became clear that the amount of work required to develop SQAPP would be more appropriately justified by building an app with global coverage. This inclination to go global was reinforced by some

hurdles experienced along the way to harmonise European and Chinese data. As a consequence, the pilot app was designed with global functionality in mind.

When looking at previously existing soil apps, they were mainly intended to provide information about the soil. There was limited focus on providing management advice on improving soil quality, and if such focus existed, it was either narrowly focused on particular aspects of soil quality (SOC), or required payment of a fee. Moreover, none of the apps reviewed by the project explicitly considered soil threats and management advice on how to mitigate them. Thus, ISQAPER aimed to develop a mobile app, referred to as the Soil Quality Assessment Application (SQAPP) by integrating existing soil quality data consisting of a range of physical, chemical and biological soil quality indicators and associated soil threats to go beyond the functionalities offered by existing soil apps.

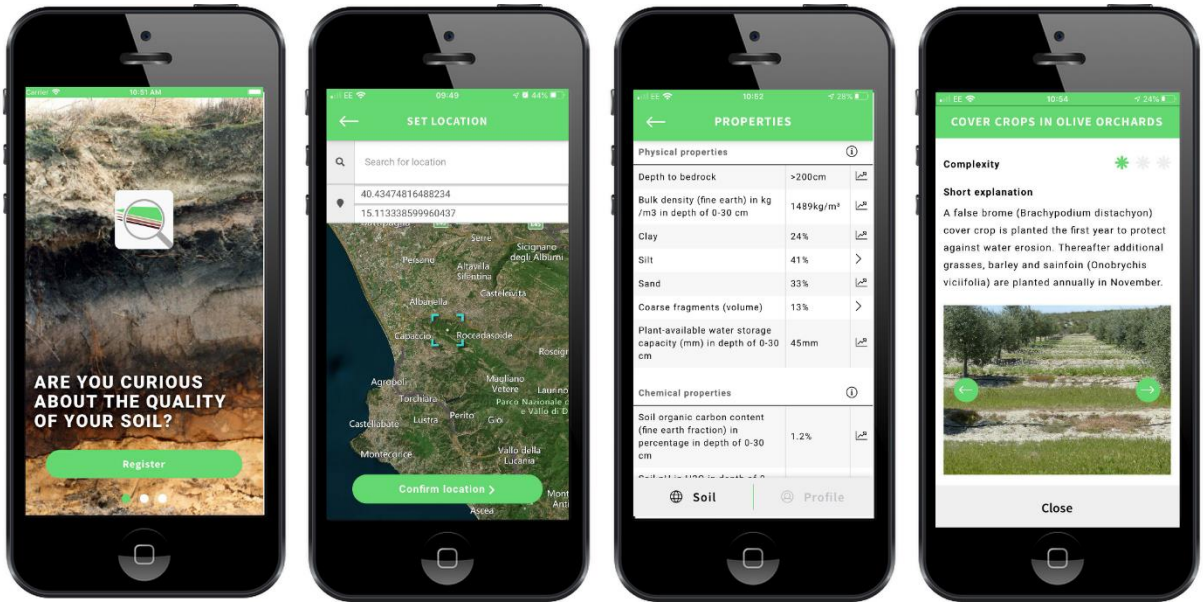

Figure 1 - Screen shots of SQAPP

SQAPP for Policy Makers

Policy makers may not be core users of the app themselves, but awareness of soil quality, soil threats and Agricultural Management Practices (AMPs) that can be implemented to improve poor conditions is essential in order to make the right policy decisions. They may furthermore be interested in the potential of SQAPP to act as an interactive soil quality assessment tool, i.e. its potential for self-reporting.

The main features of interest for policy makers are thus:

a) option to have bidirectional exchange of soil data with farmers and land users;
b) relative quality and soil threat information, allowing to plan priority interventions.

Policy makers may not directly use SQAPP themselves, but often, farmers and land users will have data about their fields' soil. Entering those data is directly relevant for farmers and land users in order to get more tailored AMP recommendations, and indispensable in case of data about land management, e.g. about (rotational) crops grown on a field and pesticides applied as there are no global datasets available about such management information. This aggregation of user input about field data and relevant AMPs recommended based on the best available data could potentially be used to help formulate policy. The SQAPP could help to fill some gaps in granular, field level data. This could potentially be a significant assistance in future planning and policy formulation.

Gathering more information about the farmers' and land users' viewpoint on AMPs suggested by SQAPP is another important aspect of interest for policy makers. As farmers and land users can evaluate the AMPs suggested, indicating which ones they have already implemented, deem inappropriate, or find potentially or definitively interesting, new data is being generated on the relevance of AMPs. If a large number of app users evaluate AMP suggestions, researchers can analyse the data and improve the AMP recommendations, e.g. by removing those that are consistently evaluated as inappropriate. This information could be useful in the formulation of future policy initiatives and serve as useful quantitative feedback on the utility and desirability of certain AMPs.

SQAPP can provide tailored advice to farmers and land managers. The advice is taken from a database on AMPs available as a portal in a dedicated iSQAPERis section on agricultural management practices recommended by SQAPP (https://www.isqaper-is.eu/sqapp-the-soil-quality-app/amps-in-sqapp). Here, links to websites with more details are provided. This portal and the app could serve as the basis for decision support to farmers and land managers in future.

The rules used in SQAPP to calculate the potential for soil quality improvement and overall soil threat level, and the ranking of AMPs have also been worked out in a spatial model. Policy makers may be particularly interested in such a spatial representation as it allows the assessment of priority areas for soil quality improvement, and the most important AMPs recommended to address site-specific combinations of poor scores on soil quality parameters and high soil threat risks.

The following section works out a number of concrete applications of SQAPP within the context of different policy instruments, concretizing the role the soil quality assessment tool can play.

Recommended Applications in Current Policy Context

The European Green Deal is an ambitious policy strategy proposed by the European Commission in 2019. It promises transformational change *inter alia* by rethinking agricultural policies in order to better protect the environment and provide a more sustainable economic and social model. It also notes that the EU should promote and invest in the necessary digital transformation and tools as these are essential enablers of the changes. The SQAPP could be such a digital tool, or serve as the basis for future apps, to enable better soil protection and assessment of soil threats in-line with the goals of the Green Deal and the related policies and strategies such as the revised Common Agricultural Policy (CAP), the Farm to Fork Strategy (F2F), the 2030 Biodiversity Strategy and the EU's forthcoming Soil Strategy. As a two-way communication tool, SQAPP can be used to support EU policy design and implementation. It can be used to engage stakeholders in different ways e.g. advisory support and farm decision-making, monitoring and data collection as well as piloting new and innovative approaches..

The app is based on a wide variety of data sources and can make scientifically sound recommendations in relation to the following Agricultural Management Practices and soil threats (among others) which are important features of the above strategies to improve soil health.

Soil Threats

- Wind & water erosion
- Loss of soil organic matter/soil carbon
- Loss of soil biodiversity
- Contamination from pesticides
- Contamination from heavy metals
- Compaction
- Salinisation

Agricultural Management Practices[1]

- **Soil Managment**
  - Minimum tillage
  - No tillage
  - Permanent soil cover / Removing less vegetation cover
  - Cover crops
  - Residue maintenance / Mulching
  - Cross-slope measure

[1] For a full overview of AMPs considered by SQAPP please see: https://www.isqaper-is.eu/land-management/amps-in-study-sites/196-experimental-framework

    - Measures against compaction
- **Nutrient Management**
    - Leguminous crop
    - Green manure / Integrated soil fertility management
    - Manuring / composting
- **Pest Management**
    - Crop rotation (a) / Control or change of species composition (b) Remediation
    - Integrated pest and disease management incl. organic agriculture Vegetation management
- **Water Management**
    - Major change in timing of activities
    - Layout change according to natural and human environment/needs
    - Area closure / rotational grazing
    - Change of land use practices / intensity level

Some of the most important commitments from the EU within the Green Deal can be directly addressed through mitigating these soil threats and the deployment these AMPs, for example the commitment to promote the goal of zero pollution from nitrogen and phosphorus flows from fertilisers through reducing nutrient losses by at least 50% in the Farm to Fork Strategy, or the Biodiversity Strategy goal to bring back at least 10% of agricultural area under high-diversity landscape features. The promotion of organic farming and reduction in the use of pesticides, key goals of the F2F Strategy, and important elements of a greener CAP as well the implementation of forthcoming Soil Strategy could also be supported by the app. Below are some concrete suggestions of how this could be done in the short to medium term.

1. **Support and promote the use of SQAPP through the Farm Advisory System (FAS) and knowledge and exchange programmes**. The app is already an excellent decision support tool which takes into account a large number of factors for land management. It is available in 13 languages and could be promoted as an accessible decision support tool that can be deployed at low cost to farmers and land managers to help them to make informed decisions. The app should assist users to take sustainability considerations into account in an integrated way.
2. **SQAPP could be used in different voluntary schemes, such as Eco-schemes, to support decision-making as well as help monitor the implementation** of a wide variety of beneficial AMPs and the results. This would be most appropriate for integration at Member States' level. This could also be a way of incentivising farmers to share data which can be used to refine and formulate future policies. National environment agencies could benefit from this information gathering source. Such broadly collected information is needed to understand what works where in order to refine recommendations.
3. **Adding SQAPP as a module to the proposed to Farm Sustainability Tool for Nutrients would be a good option**. Although this tool is proposed by the EC as a mandatory GAEC

under the CAP, it may end up being an optional intervention possibly within the FAS[2]. In any case, the SQAPP should be a good complement to the tool, as SQAPP presently does not have an in-depth model for nutrient modelling on-farm but does provide recommendations on alternative nutrient management strategies which are part of good soil management overall.

4. **Connect the SQAPP to the revision of the Farm Accountancy Data Network (FADN) as a means to collect EU-wide new data on soil management from reference farms**. There is an action to review the FADN and include sustainability indicators under the F2F. This could be an important tool to gather data across a wide variety of pedoclimatic zones and critically link it to specific Agricultural Management Practices and combinations thereof. This could be a very important measure for future research and policy formulation.

5. Similarly, **the SQAPP could be used as a self-reporting tool to track data as part of pilot projects evaluating different management techniques**, and to compare the results to a representative sample of farms not participating. The benefit would be that SQAPP can gather data from a wide variety of locations and types of farms. This could be a big benefit to support innovation projects under the EIP-AGRI operational groups or within national projects.

6. A problem in the past for developing integrated soil policy at EU level has come from challenges in the management of potentially sensitive information about private land and private data. SQAPP has a robust privacy policy which encourages private stakeholders to use it with confidence. As such, **it could be an important tool for building confidence with private stakeholders in the area of soil policy**. It is a learning tool with clear benefits for private landowners, as well as a public good with many potential benefits for sustainability. With robust rules around the use of the data – which is anonymized for research and policy-making purposes – this tool of citizen science can be an important bridge between policy makers and farmers and land managers if properly promoted and deployed.

7. **SQAPP could be employed as a tool to support Member States to achieve their commitments to reduce pesticide use** as proposed in the Farm to Fork and 2030 Biodiversity Strategies and help mainstream Integrated Pest Management (IPM). This could also support more effective implementation of the Directive on the Sustainable Use of Pesticides. The app integrates recommendations from the European Food Safety Authority on the use of pesticides, and can diagnose situations in which a farmer should reduce their pesticide use and suggest alternative strategies for pest control. It is probably the best app available for non-experts to provide estimates of pesticide environmental concentrations.[3]

8. In addition, **the data input to the app by farmers could provide valuable information for developing future pesticide policies** because it can give granular, wide-spread data

[2] CAP trilogue negotiations between the EC and co-legislators remains ongoing at time of press

[3] It is, however, worth noting that the app can give recommendations about pesticide concentrations, but not on toxicity. Neither can it account for the compound effects of different pesticides and the effects of neighbouring farmers' use of pesticides, but it can provide an entry level tool for pesticide management and awareness raising.

about the use of pesticides in practice. One useful data series could be about how different pesticides are used in combination.

9. **The app could be integrated into new and existing carbon farming initiatives to help monitor soil carbon** while linking this data to the Agricultural Management Practices employed. This could be particularly useful for understanding the effects of different combinations of AMPs and in different climates, soils and using different types of crops.
10. **The SQAPP has significant potential to support the implementation of the EU's Soil Strategy. Technology and innovation** measures in the Strategy could be informed by the SQAPP itself, and/or could build on the work done on SQAPP and support further development in order to ensure accessible mobile technology for soil monitoring and evaluation. The overall aim should be to put in place a robust framework for soil monitoring and evaluation across the EU as soon as possible, to boost relevant agricultural management and policy initiatives.

Next Steps

SQAPP represents an important new tool for farmers, land managers, researchers, and policy makers. Policy makers can use the data from the app as outlined above to help gather information about the soil quality and the AMPs that farmers are employing, or not employing. In addition, it is a tool that can be employed to help inform the farmers and land managers of their options for sustainable soil management. If this tool could be promoted by agricultural policy makers and the implementing authorities for agricultural and land management policy it could be an important step forward.

In this regard, the following steps could be taken to provide a more robust mobile app for reporting on soil quality and providing policy recommendations:

- Link the data in the app to national greening measures support information to help inform land mangers about their options. As these tend to change a support strategy to keep this information updated is necessary
- Enhance the reporting functions of the app in terms of submitting information directly to ministries for compliance and monitoring purposes (this is not currently intended function of the app)
- Export data
- Import data sets
- Develop a portal site for viewing and downloading spatial information on the potential for improvement of soil quality, overall soil threat level, and AMP rankings to address poor soil quality.
- One problem is the baseline of poor quality data availability for soil quality. Enhanced, systematic soil quality data gathering and monitoring is needed at European (and international) level. In particular better data on soil nutrients would be helpful for policy purposes.

If such steps were taken the app, or a successor app, could become a more robust tool for policy advice and soil quality monitoring.

Figure 2: Below are screen shots or possible recommendations presented by the app.