Country Guidelines and Technical Specifications for Global Mapping of Salt-Affected Soil (GSSmap)

Pillar 4 Working Group

Luca Montanarella (INSII Chairperson)

Yusuf Yigini (GSP Secretariat)

Kostiantyn Viatkin (GSP Secretariat)

Mr Christian Omuto (Africa)

Ms Maria Fantappiè (Europe)

Mr Yiyi Sulaeman (Asia)

Mr Ramazan Kuziyev (Eurasia)

Mr. Guillermo Federico Olmedo (Latin America and Caribbean)

Mr. Rachid Moussadek (NENA)

Mr. Bert VandenBygaart (North America)

Mr David Medyckyi-Scott (Pacific)

Mr Rik van den Bosch (GSP Soil Data Facility)

Ms. Costanza Calzolari (ITPS)

Mr. Rainer Baritz (GSP Pillar 5 Chairperson)

Mr Dominique Arrouays (IUSS Global Soil Map Working Group)

Global Soil Partnership

2019

TABLE of CONTENTS

1. Global Soil Partnership

Pillar Four of the GSP essentially addresses the development of an enduring and authoritative global system to monitor and forecast the condition of the Earth's soil resources.

This global soil information system has three primary functions:

1. Answering critical questions at the global scale
2. Providing the global context for more local decisions (e.g. transnational aspects of food security and degradation of natural resources)
3. Supplying fundamental soil data for understanding Earth-system processes to enable the management of the major natural resource issues facing the world (e.g. climate change, food security, biodiversity loss). These data need to be comparable with other fundamental data sets including those for weather, climate, net primary productivity, biodiversity, land cover and geology.

Pillar Four of the GSP builds an enduring and authoritative global system (GloSIS) to monitor and forecast the condition of the Earth's soil resources and produce map products at global level. The secretariat is working with an international network of soil data providers (INSII - International Network of Soil Information Institutions) and the Pillar 4 Working Group to implement data related activities. The network of International Soil Information Institutions (INSII) forms the backbone of Pillar 4 and is supported by a technical working group of soil information experts nominated by the GSP Regional Soil Partnerships (Pillar 4 Working Group). Among other tasks, this working group elaborates additional guidance for developing soil data products, which build on existing and new national and other local soil information, and for which extracts of such data fit the product scheme of the global soil information system. Technical documentation including product specifications and technical manual for soil salinity mapping will be prepared through INSII and Pillar 4 Working Group with the technical support of the ITPS (Intergovernmental Technical Panel on Soils), ICBA (International Center for Biosaline Agriculture) and GSP Soil Data Facility (Figure 4). The global assessment and the global map of salt affected areas will be based on country submissions and national soil information.

2. Background and Task

Soil salinity/sodicty is a global problem affecting agricultural productivity and food security. Quantifying the extent of salt-affected soils on a global level is therefore essential to support the design of a management plan for the sustainable use of soil resources and to ultimately mitigate this threat. The threat was discussed during the GSP 6th PA and the plenary requested GSP to address the issue (GSPPA-VI/18/Report Item 3) and conduct a global assessment to compile a Global Soil Salinity Map. The main objective of the Global Map of Salt-affected Soils (GSSmap) will be to improve national capacities in estimating the spatial variability of soil salinity/sodicity. The GSSmap will be created with a bottom-up approach, meaning that each country will provide their national maps relying on their own national data. Due to heterogeneity and asynchrony of data on soil salinity/sodicity which are available from different sources at a global scale, we underline that the first final GSSmap can be referred to as a baseline map of status salt-affected soils and will highlight the areas where soil is saline/sodic or not. Specific methodologies will be implemented depending on the available data within each country. The Global Soil Partnership (GSP) will compile and produce several guide documents containing the technical specifications. Workshops will be implemented in countries requiring specific training. Finally, the GSSmap will serve as a baseline to create a global monitoring system of salt-affected soils.

3. Context and Objectives

An important step towards sustainable management of salt-affected soils and control of salinization/sodication in agriculture fields is the knowledge of occurrence and severity of salt problems in the soil. From the global level up to farmer-fields, there is a lack of accurate extent and severity of salt problems and trends. Although there are maps portraying occurrence of salt-affected soils, there are scanty literature on global efforts to produce world map of salt-affected soils and trend of the problems. This present document outlines guidelines for supporting country-driven global mapping of salt-affected soils and baseline for monitoring.

The main objectives of the guidelines are to;

- Outline technical specifications for country-driven mapping of salt-affected soils
- Guide harmonized global mapping of salt-affected soils

4. Overview of Technical Specifications

GSP will deliver global map of salt-affected soils with contributions from individual countries. The map will be for the 0-30 and 30-100 cm depth at a spatial pixel resolution of 30x30 Arc-Second. Therefore, country-level contribution towards the global map of salt-affected soils will be expected to be for topsoil (0-30 cm) and Subsoil (30-100 cm) maps depending on data availability. The maps of salt-affected soils will be based on measured/equivalent electrical conductivity, pH, and ESP values.

Summary Table of the Specifications

Table 1: Specifications for global map of salt-affected soils

<table>
<tr><th>Data Product</th><th>Depth (cm)</th><th>Mandatory / Optional (M/O)</th><th>Spatial Entity</th><th>Deliverable Datum</th><th>Uncertainty</th><th>Validation Statistics</th><th>Delivery Method</th><th>Deadlines</th></tr>
<tr><td>Topsoil EC, pH, ESP, and Salinity or Sodicity Maps and uncertainty maps</td><td>0-30</td><td>M</td><td rowspan="2">30x30 Arc-Second Raster Grid</td><td rowspan="2">WGS 84, others upon request</td><td rowspan="2">Upper and lower 95% Confidence Interval</td><td rowspan="2">RMSE[1] ME(bias), (R^2)</td><td rowspan="4">Online (GSP[2] Data Submission Tool)</td><td rowspan="4">March 2020</td></tr>
<tr><td>Subsoil EC, pH, ESP, and Salinity or Sodicity Maps and uncertainty maps</td><td>30-100</td><td>M</td></tr>
<tr><td>Country Report</td><td>-</td><td>M</td><td colspan="4">-</td></tr>
<tr><td>Metadata</td><td></td><td>M</td><td colspan="4">-</td></tr>
</table>

Quality assurance (validation data or publication)		**M**	**-**		

5. Technical Product Specifications

5.1 Spatial entity

5.1.1 Horizontal and Vertical Resolution

The first product of global map of salt-affected soils will be given in two depths (0-30 cm and 30-100 cm) at regular fixed horizontal dimensions of 30 by 30 arc-seconds grid (approximately only 1x1km) at the equator.

5.1.2 Spatial Reference

World Geodetic System 1984 (WGS84) geographic (lat/lon) projection will be preferred for all submitted maps. The final global map of salt-affected soils will also be delivered at this coordinate reference system.

5.1.3 Extent

A generic, empty, global 30 arc-second grid will be prepared and shared with all participating countries. Countries will be expected to deliver their datasets using these standard grids.

5.1.4 Excluded Non-soil Areas

Data providers are expected to provide a continuous surface for their map predictions. The GSP secretariat will mask out non-soil areas occupied by non-soil materials, including permanent water and ice, bare rock and sealed surfaces (urban). No attempt will be made to specify the types or proportions of non-soil materials in a grid cell. Excluded grid cells values of soil properties should be identified as no data in the final global product.

5.2 Input data for mapping soil salinity

The current call for global map of salt-affected soils envisages use of existing data to produce the country-level map. This section provides the specifications for existing input data requirements for mapping salt-affected soils. The existing input data are categorized as: measured soil data, remote sensing data, and proximal sensing data.

(i) **Measured soil data**: Soil salts are preferably determined from measured electrical conductivity of a saturated soil paste (EC_{SE}). In many laboratories and in the field, electrical conductivity (EC) is often determined from the soil –water mix. This EC can be transformed to EC_{SE} depending on the soil texture, organic matter and clay content. Thus, in general, the minimum measured soil dataset necessary for classifying soil salinity/sodicity is as given in Table (2). This dataset is commonly available in most soil maps

Table 2: Measured soil data for mapping salinity and sodicity/alkalinity

Data type	Description	Remarks
1. pH	(-)	Used for diagnosis of alkaline soils
2. EC_{SE}	Saturation extract (EC_{SE}) (dS/m)	Diagnosis of saline soils
3. ESP	Exchangeable Sodium Percent	Diagnosis of sodic soils
4. SAR	Sodium absorption ratio(SAR)	Diagnosis of sodic soils using data of the saturation extract

(ii) **Other measured soil data (alternative):** Although soil salts are customarily determined from electrical conductivity measurements, there are various methods in the literature using other soil properties such as electrical conductivity of soil-water mix (soil solutions), total soluble salts (TSS), pedo-transfer functions, etc. It's recommended that the equivalent EC_{SE} is determined for these methods and the conversion method clearly explained in the metadata submission. Soil salt ionic composition is also often used to separate saline from sodic and sodic-saline soils. They may be included as well. They include sodium (Na^{+}), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), and sometimes Potassium (K^{+}) and anions of Chlorides (Cl^{-}), Carbonates ($C0_3^{2-}$), Sulphates ($S0_4^{2-}$), Bicarbonates ($HC0_3^{-}$) and Nitrates ($N0_3^{-}$).

---

[1] Rusydi AF. 2018. Correlation between conductivity and total dissolved solids in various types of water: A review. IOP Conf. Ser.: Earth Environ. Sci. 118: 1-6. doi :10.1088/1755-1315/118/1/012019

[2] Corwin, D. L., and K. Yemoto. 2017. Salinity: Electrical conductivity and total dissolved solids. Methods of soil analysis 2. doi:10.2136/msa2015.0039

(iii) **Remote sensing data** (**Optional**): Soil salts affects vegetation growth characteristics such as ground vegetation cover and light reflectance. At advanced stages of salt accumulation on the land surface, light reflectance from the surface also changes. These characteristics are detectable by remote sensing. In this regard, invasive methods using remote sensing indices of the multispectral bands can be used to identify salt affected areas. Furthermore, with calibration with ground-truthed data, climate data, and land cover characteristics, statistical correlations can be established to quantify soil salinity/sodicity. This approach is more appropriate in areas with limited measured soil data on salinity/sodicity. Table 3 gives the minimum data requirement for classifying salt-affected soils using remote sensing images.

Table 3: Data requirements for salinity classification using remote sensing

Data type	Remark
1. Multispectral images	For image indices
2. Measured soil electrical conductivity (dS.m-1)	For calibration
3. Climate data (mean annual rainfall and mean daily temperature)	For prediction

(iv) **Electromagnetic induction** (**Optional**): This method can also be used to determine soil salinity. Here, electromagnetic (EM) soil salinity sensor is used to measure salinity in the field and the results calibrated with selected EC_{SE} measurements to improve the instrument accuracy. Table 4 gives data requirements for soil salinity classification using EM method.

Table 4: Data requirements for classification using electromagnetic induction

Data	Remark
EM Sensor data	
EC_{SE} measured data for calibration	Limited samples for calibration

<u>Summary input data requirements</u>

(a) **Soil data (0-30 cm and 30 -100 cm soil depth):** Electrical conductivity, pH, Exchangeable Sodium Percent (ESP), Or salt concentration (TSS)

1) Electrical conductivity of saturated soil extract in dS/m (or its equivalent with documented conversion models) or Total Soluble Salts (TSS) (mg/l)
2) pH, ESP (and optional Sodium Absorption Ratio)
3) (Optional) - soluble ion contents (Na^+, Cl^-, SO_4^{2-}, CO_3^{2-}, HCO_3^-) in cmol/Kg

(b) **Spatial/environmental data (predictors)**: climate, relief, land use/cover, parent material

1) Climate: weather station or map of mean annual amounts (rainfall and/or temperature)
2) Relief: Elevation (image or contour map of altitudes)
3) Soil type map (with geology information and/or geology map with lithology information)
4) Land use/cover map
5) Remote sensing images: Mean annual/season images with visible bands (BGR), near infrared (IR) bands, and shortwave band 1 and 2.
6) (Optional) hydrogeology map (with groundwater level/water rest level information)

(c) **(Optional) other ancillary information**

1) Bulk soil apparent electrical conductivity (and conversion model to EC of saturated soil paste extract in dS/m)
2) Gamma/microwave/Radar images

5.3 Classification of salt-affected soils

Classification of salt-affected soils will be based on measured or equivalent EC_{SE}, pH, pH, and ESP.ESP FAO (2006) salinity classification criteria shown in Table 5 will be preferred.

Table 5. Soil salinity/sodicity classification

Types of salt-affected soils					
Soil property	**Unit/ Symbol**	**Threshold**			
		Non-affected	**Saline**	**Saline-sodic**	**Sodic**

Electrical conductivity	Ec_e (dS/m)	<2	> 4	> 4	< 4
Exchangeable sodium	ESP	< 15	< 15	> 15	> 15
pH	-	0-14	< 8.5	< 8.5	> 8.5

Severity of salt-problems

Salinity (EC_{SE} dS/m)			**Sodicity (ESP)**	
Severity level	FAO (2008)	Richard (1954)	Severity level	Abrol et al. (1988)
None	< 0.75	0 - 2	None	< 15
slight	0.75 - 2	2 - 4	Slight	15 - 30
Moderate	2 - 4	4 - 8	Moderate	30 - 50
Strong	4 - 8	8 - 16	High/Strong	50 - 70
Very Strong	8 - 15	> 16	Extreme/V. Strong	> 70
Extreme	> 15			

5.4 Improvement of soil salinity/sodicity map

In the event that there is an opportunity to improve the soil salinity/sodicity maps, then the following steps are recommended to guide the planning and development of the new maps:

1. Use the uncertainty maps developed using secondary data and the country's preferred sampling strategy to strategize on sample allocation for the new data

2. Use the GSP Soil salinity/sodicity manual to develop new input maps and new EC map
3. Reclassify the EC map to produce the new and improved salinity/sodicity map
4. Submit the new map of salt-affected soils according to the procedures outlined in this guideline

Suppose the update focus is not necessarily on new data but on the approach and/or predictors, then it's recommended that:
1. The new approach be identified and its requirements evaluated to assess if the existing information/data complies with the requirements. Where necessary adjustments should be made targeting meeting the approach requirements. If the update is focusing on new predictors, then the assessment and evaluation of the adequacy of the predictors should be done.
2. Use the GSP Soil salinity/sodicity manual to develop new (input maps and) EC map
3. Reclassify the EC map to produce the new and improved salinity /sodicity map
4. Submit the new map of salt-affected soils according to the procedures outlined in this guideline

6. Metadata

All data developed and submitted for the GSSmap are required to have associated metadata. GSP Secretariat requires metadata to be provided during the submission. It is important to understand that deliverables are not considered complete without metadata. A completed metadata form is known as a metadata record. The metadata form is given in Annex I, and will also be provided as a web form which should be filled-in to accompany each submitted dataset. Where available, copies of any other documentation relevant to each dataset may be given during the submission. Examples include:

- Licensing information
- Copyright information
- Disclaimers
- Metadata statements
- Technical Reports or manuals.

7. Product development and quality assurance

7.1 **Product development**

The GSP preferred input data for soil salinity mapping is measured soil EC_{SE} (Soil Survey Staff, 2014[1]; FAO, 1970[2]). Unless this data is not available, EC_{SE} equivalent obtained by conversion from other

data types may be used. The preferred predictive mapping method is regression kriging or Random Forest (ref. GSOC Cookbook; http://www.fao.org/3/I8895EN/i8895en.pdf)

---

[1] Soil Survey Staff. 2014. Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 51, Version 2.0. R. Burt and Soil Survey Staff (ed.). U.S. Department of Agriculture, Natural Resources Conservation Service (https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1244466.pdf)

[2] FAO. 1970. Physical and chemical methods of soil and water analysis. Bulletin No. 10. FAO, Rome (http://www.fao.org/soils-portal/resources/soils-bulletins/en/)

7.2 **Product validation**

Countries should validate their maps with measured EC data and present validation results together with the maps. Validation result should be supported by sufficient data for the GSP to check the quality of the submitted maps.

Validation can be done in several ways (detailed description of the validation techniques will be provided in the technical manual):

a. Validation with an independent dataset. In this case, the map is validated with a dataset that was not used for mapping. This dataset should be submitted to the GSP together with validation results to ensure reproducibility of quality control.
b. Validation through data splitting. In this case, the dataset is split before mapping (e.g. 85% and 15% of the data), one part is used for prediction and another part is used for validation. Part of the data that was used for validation should be submitted to the GSP together with validation results to ensure reproducibility of quality control.
c. Cross-validation (only DSM modelling). In this case, several model realisations are produced with subsets of the data, ensuring validation of the model at each step. The model object containing predictions and residuals for each fold should be submitted to the GSP together with validation results to ensure reproducibility of quality control.
d. If the country submits an already published map which was quality checked by peer-review process in an internationally indexed scientific journal, then such publication should be provided as a quality assurance of the map (no need to submit validation data in this case).

8. Product Delivery

The results from the survey on national soil information systems shared by the GSP secretariat, indicated that for most countries, national data on EC are available. Therefore, it is anticipated that the countries will produce the first baseline map of soil salinity. The following options are proposed to the countries to produce their own national soil salinity map:

8.1 Mandatory Products

1. **Topsoil (0-30 cm) Soil Electrical Conductivity (dS/m):** Include country-level topsoil electrical conductivity and uncertainty maps (0-30 cm) created with digital soil mapping approach based on measured electrical conductivity (EC_{SE}) and set of environmental covariates. The product format shall be geotiff files with 30 arc-seconds resolution (approximately 1 x 1 km). The pixel values should be EC_{SE} (dS/m).

2. **Subsoil (30 – 100) Soil Electrical Conductivity (dS/m)**: Include national subsoil electrical conductivity and uncertainty maps (30-100cm) created with digital soil mapping based on measured electrical conductivity (EC). The product format shall be geotiff files with 30 arc-seconds resolution (approximately 1 x 1 km). The pixel values should be EC_{SE} (dS/m).

3. **Topsoil (0-30 cm) Soil pH:** Include country-level topsoil pH and uncertainty maps (0-30 cm). Format: geotiff files with 30 arc-seconds resolution (approximately 1 x 1 km). Pixel values: pH value.

4. **Subsoil (30-100 cm) Soil pH:** Include country-level subsoil pH and uncertainty maps (30-100 cm). Format: geotiff files with 30 arc-seconds resolution (approximately 1 x 1 km). Pixel values: pH value.

5. **Topsoil (0-30 cm) Exchangeable Sodium Percent (ESP):** Include country-level topsoil ESP and uncertainty maps (0-30 cm). Format: geotiff files with 30 arc-seconds resolution (approximately 1 x 1 km). Pixel values: ESPvalue.

6. **Subsoil (30-100 cm) Exchangeable Sodium Percent (ESP):** Include country-level subsoil SAR and uncertainty maps (30-100 cm). Format: geotiff files with 30 arc-seconds resolution (approximately 1 x 1 km). Pixel values: ESP value.

7. **Topsoil (0-30cm) Salinity / salt affected soils:** Include country-level topsoil map of salinity and uncertainty maps (0-30 cm). Format: geotiff files with 30 arc-seconds resolution (approximately 1 x 1 km). Pixel values: Soil salinity class
8. **Subsoil (30-100 cm) Salinity / salt affected soils:** Include country-level topsoil map of salinity and uncertainty maps (30-100 cm). Format: geotiff files with 30 arc-seconds resolution (approximately 1 x 1 km). Pixel values: Soil salinity class

Supplementary data:

- Metadata (submitted through the online form or otherwise);
- Country report (electronic document);
- Quality assurance data - one of the following:
    - Validation dataset (table format or shapefile)
    - Model object with cross-validation data (R file);
    - Peer-reviewed publication of the results (electronic document or link to online access).

The following flow is foreseen in country-level mapping of salt-affected soils and final submission for producing global soil salinity map:

a. Countries have EC data and will apply the given technical specifications to produce and share their national soil salinity and uncertainty maps and associated metadata

b. Countries have EC data but lack adequate technical expertise to produce and share national soil salinity map. Training sessions should be organized to support these countries to produce and share their soil salinity maps. Alternatively, if those countries elect to authorize GSP to produce the maps on their behalf, then GSP secretariat will arrange to facilitate the data exchange and mapping.

c. Countries do not have EC data but have the technical expertise to produce the soil salinity maps. In this case, the countries are encouraged to mobilize resources necessary for generating national EC data for producing the salinity maps

d. Countries do not have EC data nor technical expertise to produce soil salinity map. For the foreseeable global soil salinity mapping timeline, such countries may have their tiles gap-filled by the GSP Secretariat in the interim while awaiting for more accurate date. The countries will be encouraged to mobilize resources for generating national EC data and for capacity building to produce national soil salinity map

e. Countries with EC data but prefer to use their own specifications to produce and share national soil salinity map. Such countries will be requested to engage GSP Secretariat for further modalities.

GSP Secretariat will also develop a gap filling strategy for the countries which will not be able to provide data during the required time span.

9. Data Submission Procedure

9.1 File Naming Conventions and Directory Structure

GSP Secretariat will provide countries an online data submission facility. The deliverables can be uploaded as individual files or as compressed archives of files (.zip, .rar, 7z).
Structure is as follows:

|_ Maps

EC

|_ National Soil EC Map 0-30 cm*(ISO3CountryCode_SalinityMap030.tiff)*

|_ National Soil EC Map 30-100 cm *(ISO3CountryCode_SalinityMap30100.tiff*)

|_ Uncertainty EC Map 0-30 cm *(ISO3CountryCode_UncertaintySalinityMap030.tiff*)

|_ Uncertainty EC Map 30-100 cm *(ISO3CountryCode_UncertaintySalinityMap30100.tiff)*

ESP

|_ National Soil ESP Map 0-30 cm *(ISO3CountryCode_ESPMap030.tiff)*

|_ National Soil ESP Map 30-100 cm *(ISO3CountryCode_ESPMap30100.tiff*)

|_ Uncertainty ESP Map 0-30 cm *(ISO3CountryCode_UncertaintyESPMap030.tiff*)

|_ Uncertainty ESP Map 30-100 cm *(ISO3CountryCode_UncertaintyESPMap30100.tiff)*

pH

|_ National Soil pHMap 0-30 cm *(ISO3CountryCode_pHMap030.tiff)*

|_ National Soil pH Map 30-100 cm *(ISO3CountryCode_pHMap30100.tiff*)

|_ Uncertainty PH Map 0-30 cm *(ISO3CountryCode_UncertaintyPHMap030.tiff*)

|_ Uncertainty PH Map 0-30 cm *(ISO3CountryCode_UncertaintyPHMap30100.tiff)*

EC

|_ National Soil EC Map 0-30 cm *(ISO3CountryCode_ECMap030.tiff)*

|_ National Soil ECMap 30-100 cm *(ISO3CountryCode_ECMap30100.tiff*)

|_ Uncertainty EC Map 0-30 cm *(ISO3CountryCode_UncertaintyECMap030.tiff*)

|_ Uncertainty EC Map 0-30 cm *(ISO3CountryCode_UncertaintyECMap30100.tiff)*

Documents

|_ Report (ISO3CountryCode_Report.doc, docx)

|_Quality_Assurance

|_Validation data or a peer-reviewed publication

9.2 Formats

The GIS files will be delivered in GeoTIFF format. GeoTIFF is a standard .tif or image file format that includes additional spatial (georeferencing) information embedded in the .tif file as tags. These are called embedded tags, tif tags. These tags include raster metadata such as spatial extent, coordinate reference system, resolution, no data values.

10. Quality Assurance/Quality Check

Each country will be responsible for carrying out basic Quality Assurance/Quality Control (QA/QC) of all data prior to supplying it to the GSP Secretariat. Quality Assurance can be described as the process of preventing errors from entering into datasets; while Quality Control can be described as the process of identifying and correcting existing errors in datasets.

All datasets should be checked for:

- Spatial errors (extent, projection)
- Units (EC ds.m-1)
- Completeness of data and metadata (are all mandatory datasets present and documented?)

- Consistency with data shown in any accompanying documents (such as reports or drawings),
- Compliance with the Data Standards described in this document.
- Consistency of the reported validation results with the provided data.

The final QA/QC for the national and global datasets will be facilitated by the GSP Secretariat through it's technical networks (INSII, P4WG, and Intergovernmental Technical Panel on Soils (ITPS)) will give the final clearance to the global dataset before the public release.

11. Process and Timeline

The proposed timeline, deadlines for milestone activities and tasks as follow;

Outputs	**Activities**	**Contributors**	**Date**	**Clearance**
Concept Note	Concept Note	GSP Secretariat, INSII, P4WG, ITPS	Done	ITPS
Technical Specifications	Zero Draft	GSP Secretariat, P4WG, SSAG	Done	P4WG, ITPS (out of session)
	Reviewing, Revising, Finalising	P4WG, ITPS, SSAG	July-August 2019	
	Launch		Done	
Kick-off	National Salinity Expert Appointment	INSII, Focal Points, ICBA	August-September 2019	
	Feedback on Capacities	INSII, FP	August September 2019	
	Mapping, Modelling	INSII	October 2019 - March 2020	
Capacity Development	Technical Manual	P4WG, SSAG, ICBA	October 2019 (Launch)	ITPS, INSII
	Training Materials	P4WG, SSAG	November 2019	P4WG
	Training (NENA)	ICBA, SSAG	November 2019 - March 2020	-
	Training Materials	SSAG		

	Training (Africa)	ICBA, SSAG		
	Training (Eurasia)	ICBA, SSAG		
	Training Latin America	SSAG		
	Training (Asia)	SSAG		
	Training (Europe)	SDF		
	Training (Pacific)	CSIRO		
Data Collection	National Submissions	INSII	October 2019 - May 2020	-
	Gap Filling Strategy, Data	GSP Secretariat, SSAG	December 2019 - May 2020	
	QA/QC of National Products	GSP Secretariat, P4WG	March 2020 - May 2020	
GSSmap	Harmonisation and Compilation	GSP Secretariat, P4WG	January 2020 - May 2020	ITPS
	QA/QC	ITPS, INSII	May 2020 (INSII off-session)	
	Metadata Table	INSII	May 2020 (INSII off-session)	
	Launch (v1.0)	GSP Secretariat, ITPS	June 2020 (8th GSPPA) - Side Event	
Publications	Technical Report	GSP Secretariat, P4WG	June 2020 - Public Release	ITPS

	Scientific Article	GSP Secretariat, P4WG, ITPS, SSAG	May 2020 (Start Writing) June - July 2020 (Submission)	Peer Reviewed
	Policy Brief	GSP Secretariat, ITPS	September 2020	ITPS
	Post release Plan	GSP Secretariat, P4WG	May June 2020	
Dissemination & Communication	Leaflet, Posters	GSP Secretariat	June 2020	P4WG,GSP Communication Team via FAO OCCI
	Web Services (GloSIS)	GSP Secretariat, WebGIS Consultant	June July 2020	

Annex

ANNEX I. Metadata

Attribute	**Example**
Total number of soil profiles/sampling locations	
Number of soil profiles	
Number of topsoil samples	
Number of subsoil samples	
Number of auger samples	
Sampling Depth	*soil horizons, topsoil: 0-30; subsoil: 30-100*
Georeferencing method	*GPS coordinates / legacy maps*
Sampling (data collection) Period	*1980-2008*
EC measurement unit	*dS.m-1*
EC determination method	*measured/estimated*
(if measured) EC measurement method	*conductivity meter in a soil paste extract*
(if measured) EC soil/water ratio	*`1:5` or 1:2.5 or 1:2, etc*
(if estimated) EC estimation method	*calculated from TSS*
(if estimated) EC estimation formula	*Ec (dS m-1) = TDS(ppm)/640*
Mapping method	*Conventional mapping / Digital Soil Mapping*
(if conventional) Conventional method	*class-matching / geomatching*
(if conventional) Input maps used	*soil map, land use map*
(if conventional) Soil classification of the input map	*WRB*
(if conventional) Soil map scale	*1:1 000 000'*
(if DSM) DSM method	*Regression Kriging*
(if DSM) Predictors used	*temperature, precipitation, elevation, soil type*
(if DSM) Covariates source(s)	*worldclim, usda, national soil map*
Validation method	*cross-v / data splitting / independent validation*
R2 (Amount of variance explained)	*0.54*
mean error (ME)	*-0.05*
root mean squared error (RMSE)	*1.2*
EC map units	*dS.m-1*

Uncertainty estimation method	*standard deviation from regression kriging*
Uncertainty map units	*dS.m-1*
Map author(s)	
Contributing author(s) in case of scientific/book publication	
Data provider institute(s)	
E-mail(s)	
Address(es)	
Citation	
Comments/remarks	

---

[1]RMSE: Root Mean Square Error

[2]To be provided by the GSP Secretariat

[3] FAO (2006). Guidelines for Soil Description. FAO, Rome (http://www.fao.org/3/a-a0541e.pdf)