Food and Agriculture Organization of the United Nations

7th Meeting of the International Network of Soil Information Institutions (INSII)

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Online meeting

Global Map of Salt-Affected soils (GSASmap v1)

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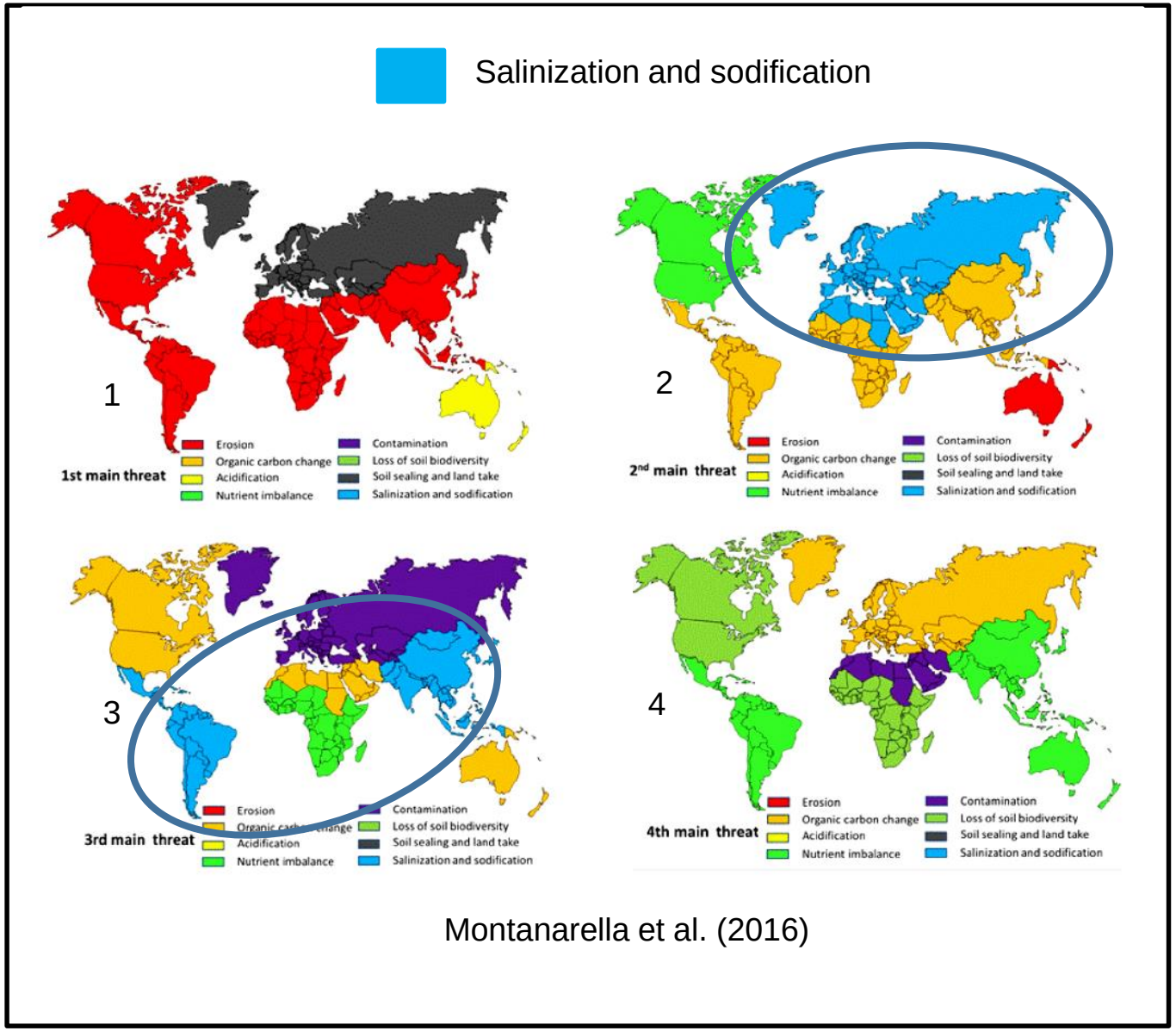
INSII

GLOBAL SOIL PARTNERSHIP

Background to GSASmap

- Arising from the need for (1) consistent update (2) salt accumulation in agricultural soil
- Highly salted soils are not very agriculturally productive (and are mostly shunned by farmers)
- Salt accumulation in soil is 2nd and 3rd priority of the global soil threats
- Where is salt accumulation actively progressing (and at what rate?) particularly in agricultural areas
- Recommendation from the 6th GSP Plenary Assesmbly (GSPPA-VI/18/Report, 2018)



Montanarella et al. (2016)

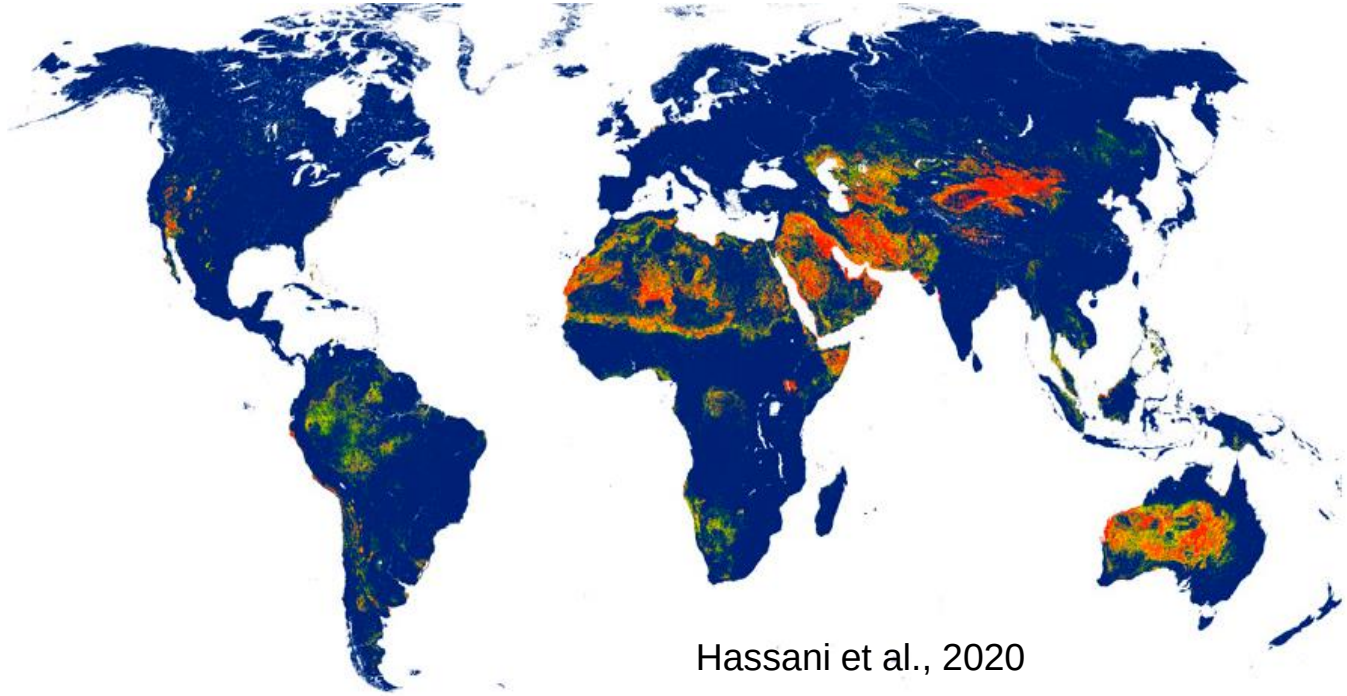
Background to GSASmap

- Inadequate involvement or coordination or sensitization of countries on SAS data

- GSASmap provides twin objectives
  - Showing distribution of highly salted soils (SAS zones)
  - Showing risk areas (slightly-to-moderately salted soils that can be rescued) particularly in agricultural areas

- GSASmap initiative provides coordination with countries (INSII) & framework for periodic GSASmap update

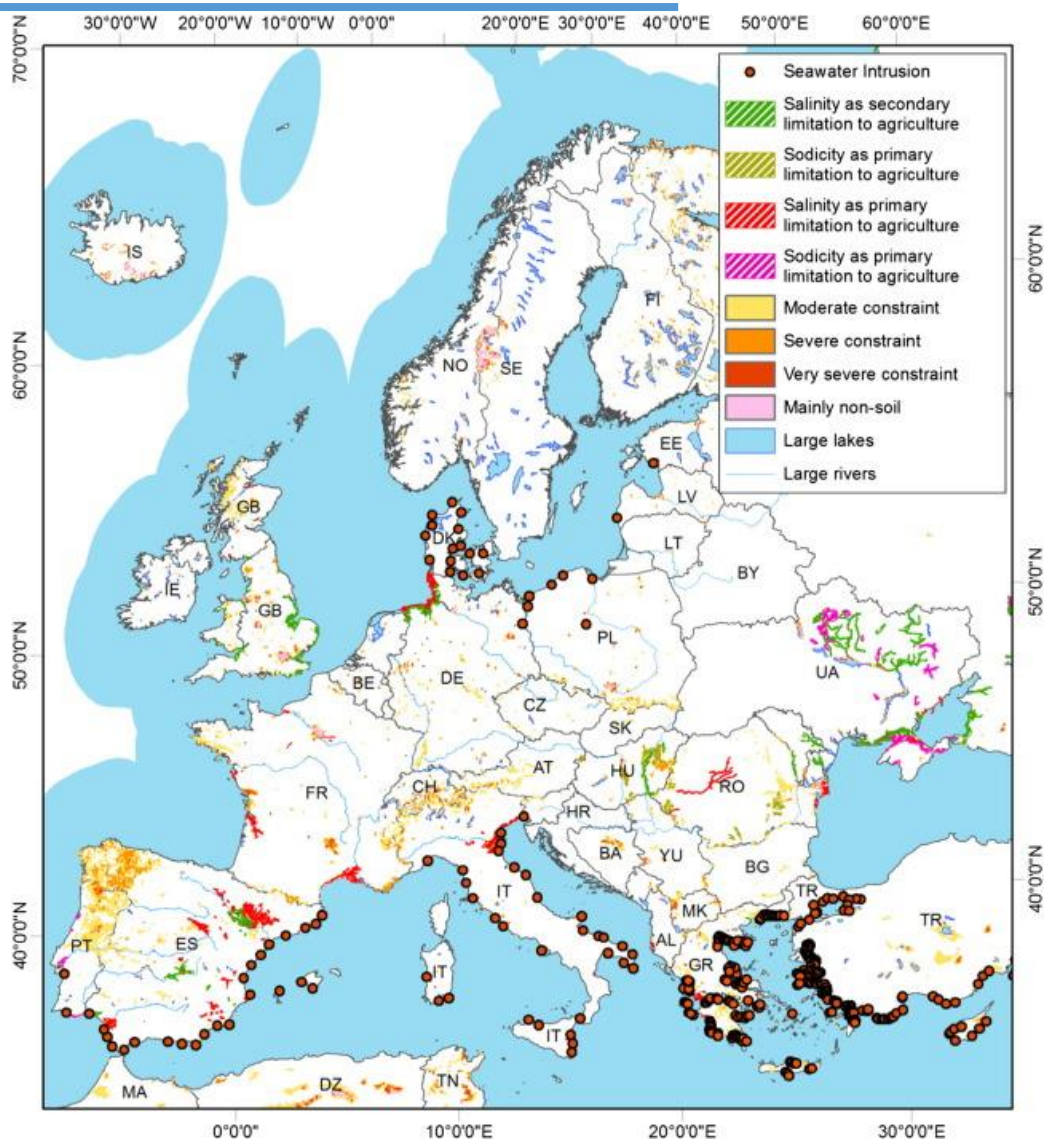
- Mechanism for early detection of salt problems in agricultural soil



Hassani et al., 2020

Considerations on GSASmap development

- Natural SAS (due to arid climate, parent material, proximity to salty water, etc.)
  - Important ecological niche
- SAS due to land use activities (e.g., irrigation activities, agricultural activities, groundwater exploitation, land use changes, etc.)
- Especially in **agricultural** or other **risk** areas
- Capacity building, mobilization, and awareness creation on salts in soil



Daliakopoulos et al. (2016)

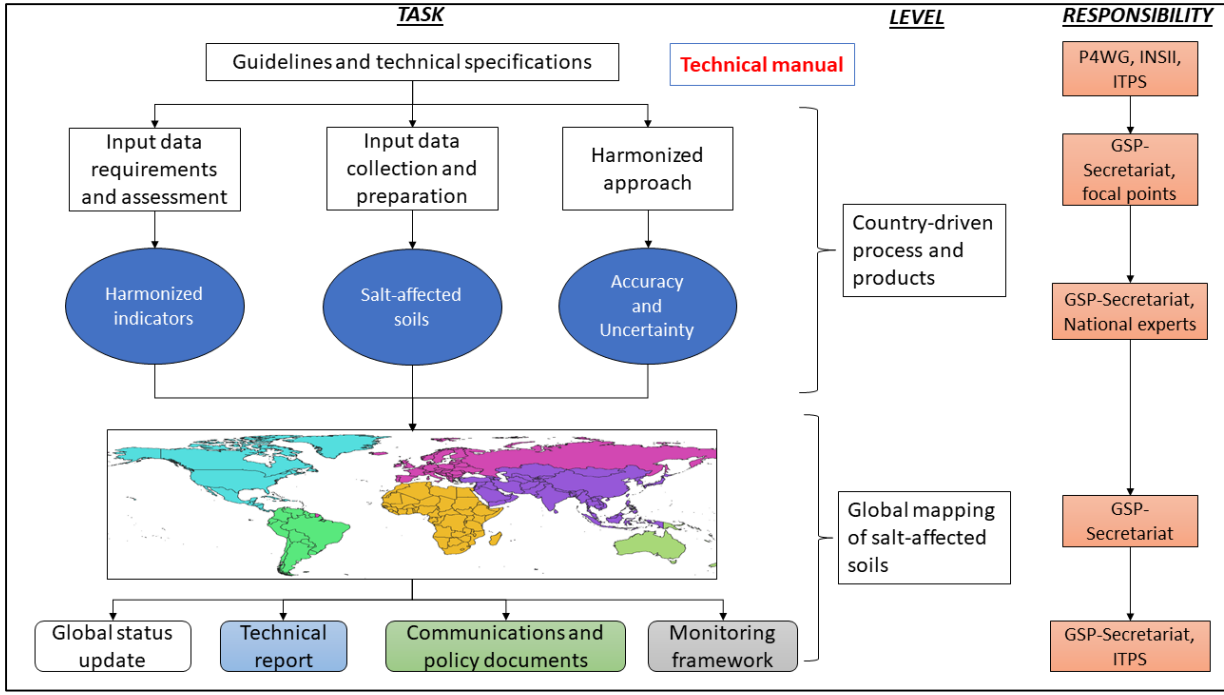
Considerations on GSASmap development

- Owing to data challenges, use soil-property approach in identifying occurrence of SAS
  - EC, pH, ESP/SAR, TSS, etc.
- Thresholds are given considering salt impacts on soil and plant health
- Further differentiation based on types of salts is needed
- Topsoils and subsoils
- Soil assessments focused on early detection of salt problems in agricultural areas recommend severity levels
- GSASmap to provide long-term average SAS and structural foundation for monitoring salinization/sodification

Salinity (EC_e dS/m)			Sodicity (ESP)		
Severity level	FAO (2006)	Richard (1954)	Severity level	Abrol et al. (1988)	Amrhein (1996)
None	< 0.75	0 - 2	None	< 15	< 6
Slight	0.75 - 2	2 - 4	Slight	15 - 30	6 - 10
Moderate	2 - 4	4 - 8	Moderate	30 - 50	10 - 15
Strong	4 - 8	8 - 16	High/Strong	50 - 70	15 - 25
Very Strong	8 - 15	> 16	Extreme/V. Strong	> 70	> 25
Extreme	> 15				

Approach for GSASmap development

- Country-driven approach
- Engaged experts from more than 120 countries
- 113 countries with more than 350 national experts involved in six 2-week harmonization workshops
- Use measured soil properties (EC, pH, ESP/SAR)
- Incorporating spatial information on drivers/indicators of salt-accumulation (parent material, climate, land use, remote sensing, etc.)



Approach for GSASmap development

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> regmodelSuit(LESOTHOSOIL,ESP,geology,hydrogeology, soilmap, slopelength, slope, valleydepth, dem, rain, landcover, PCA1,PCA2,PCA3,PCA4,PCA5)

                       ME        RMSE        R²         NSE
RandomForest    0.15535268   0.2730253   0.9231544   0.9762591
Cubist          0.06507252   0.2102831   0.9543207   0.9835552
Ranger          0.17893447   0.3056874   0.9031748   0.9770586
QuantRandForest 0.06884600   0.2660837   0.9157335   0.9779208
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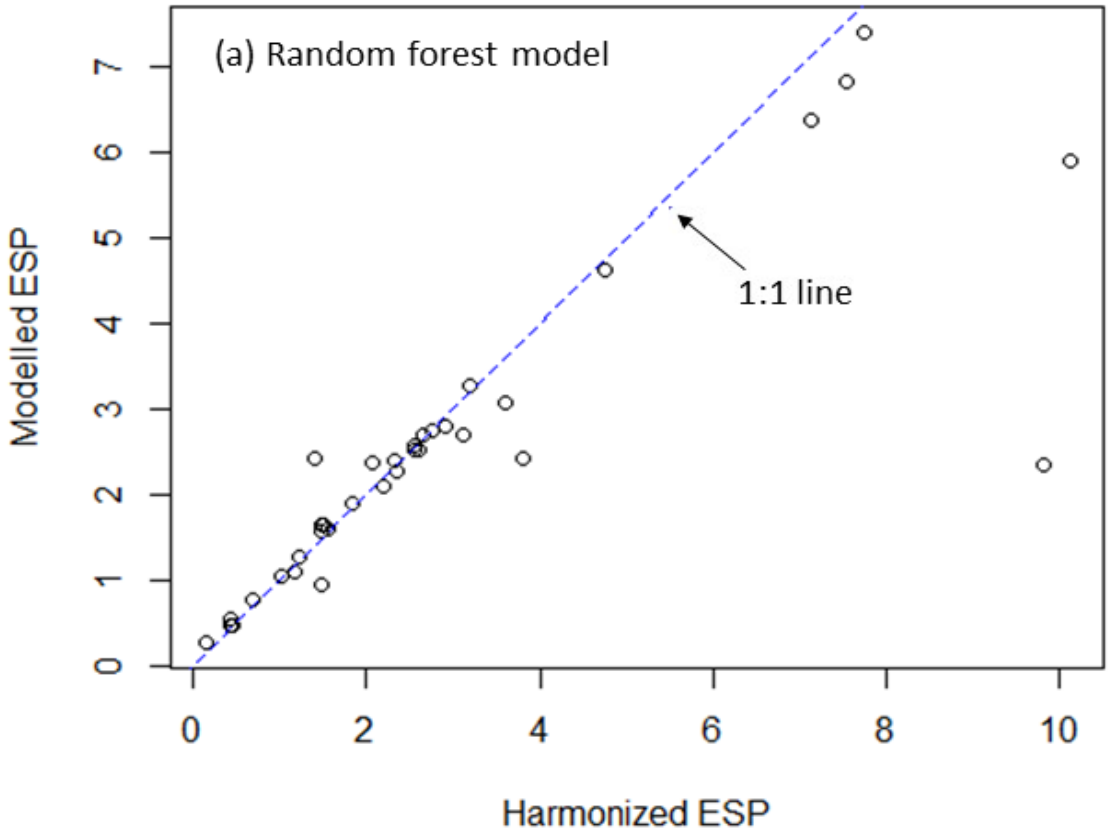
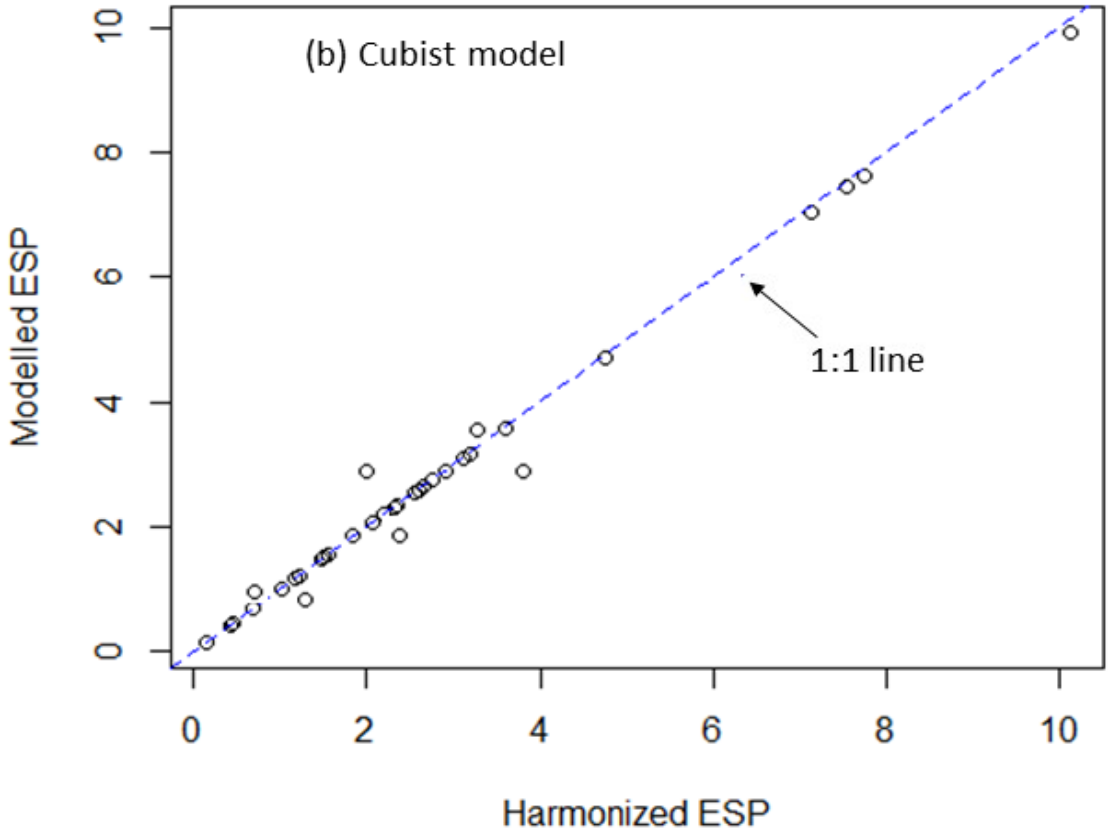
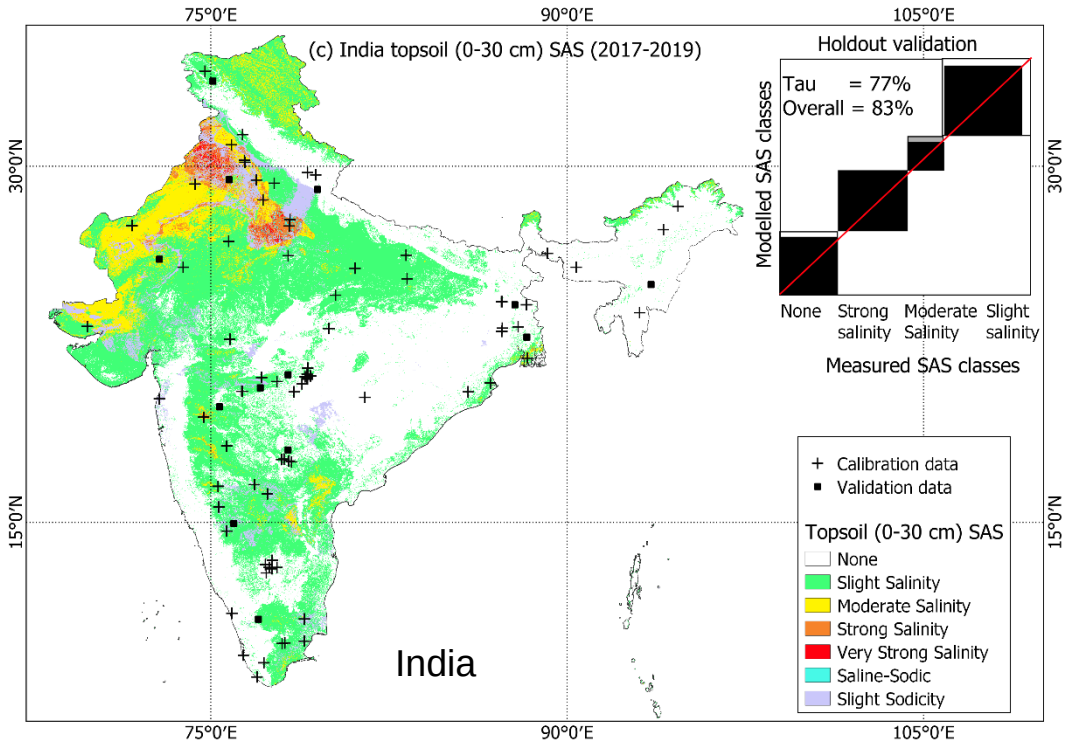
Holdout validation outputs for selected models

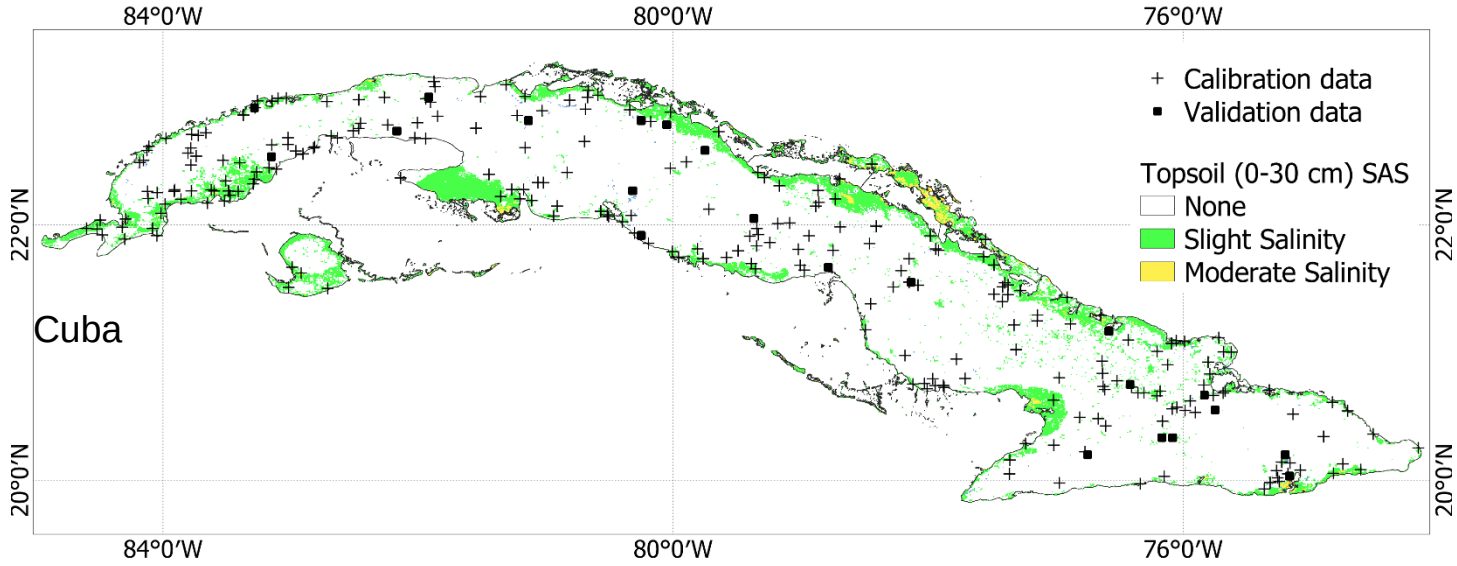


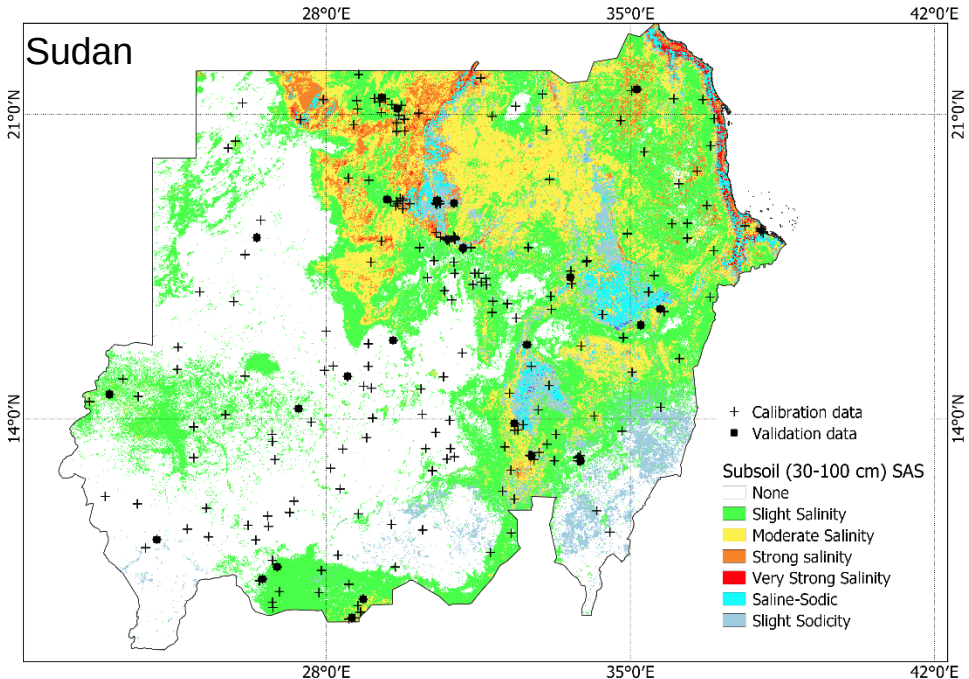


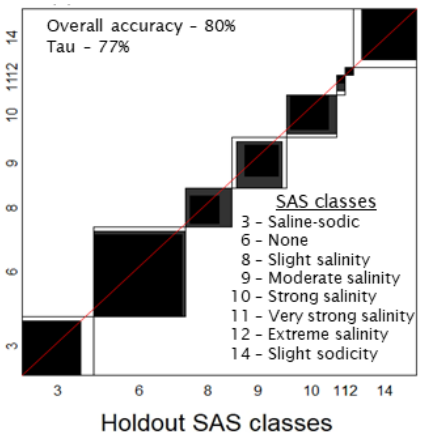
Key points

- Map produced using over 250,000 sampling locations from 118 countries
- GSASmap approach is able to identify highly salted SAS zones as well as low salt areas (slight to moderate) which are at risk of salt problems
- Low salt areas (slight - moderate) are very important for SSM in agriculture

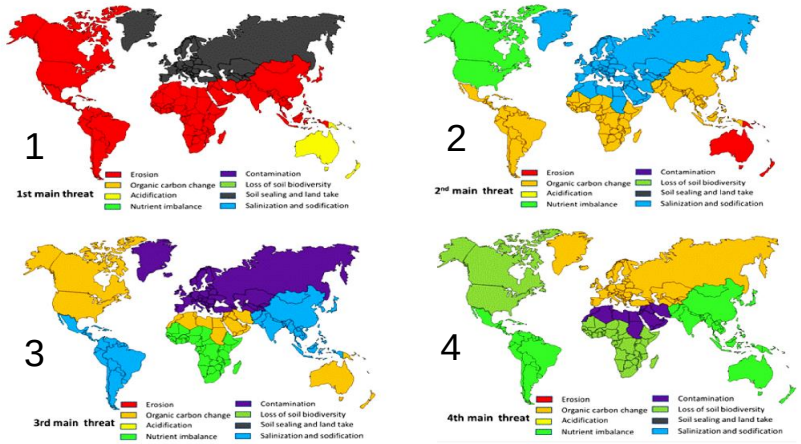




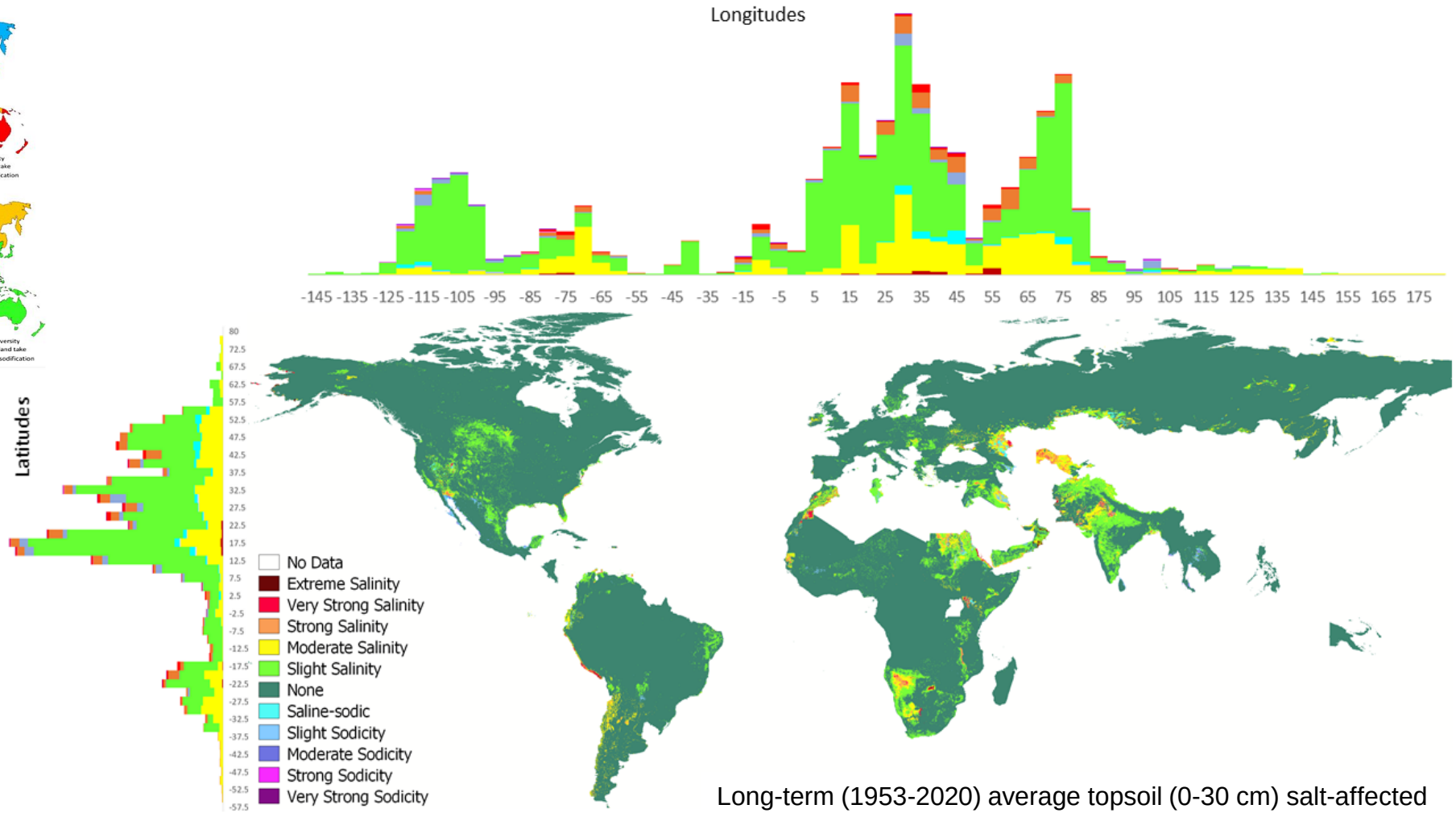




Key points



SAS Classes	Area (M Ha)	% Topsoil SAS	% Total Land area
Very Strong Sodicity	0.3	0.0	0
Strong Sodicity	0.9	0.1	0
Moderate Sodicity	4.1	0.4	0
Extreme Salinity	7.2	0.6	0.1
Very Strong Salinity	17.8	1.6	0.1
saline_sodic	24.0	2.1	0.2
Slight Sodicity	34.8	3.0	0.3
Strong Salinity	75.8	6.6	0.6
Moderate Salinity	268.0	22.2	2
Slight Salinity	726.5	63.4	5.6

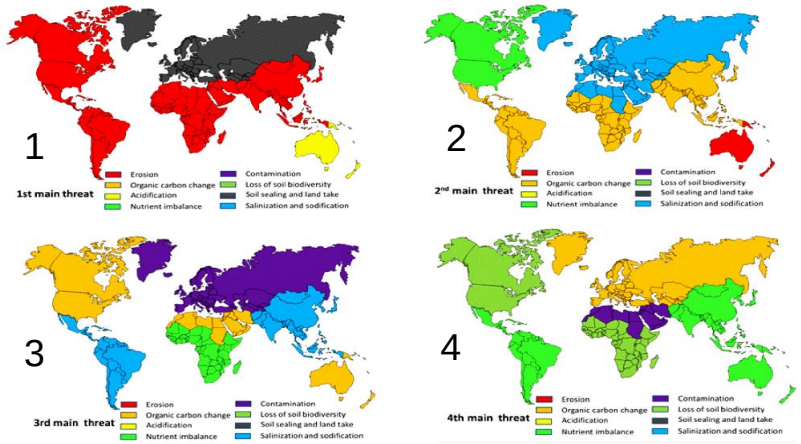


Long-term (1953-2020) average topsoil (0-30 cm) salt-affected soils

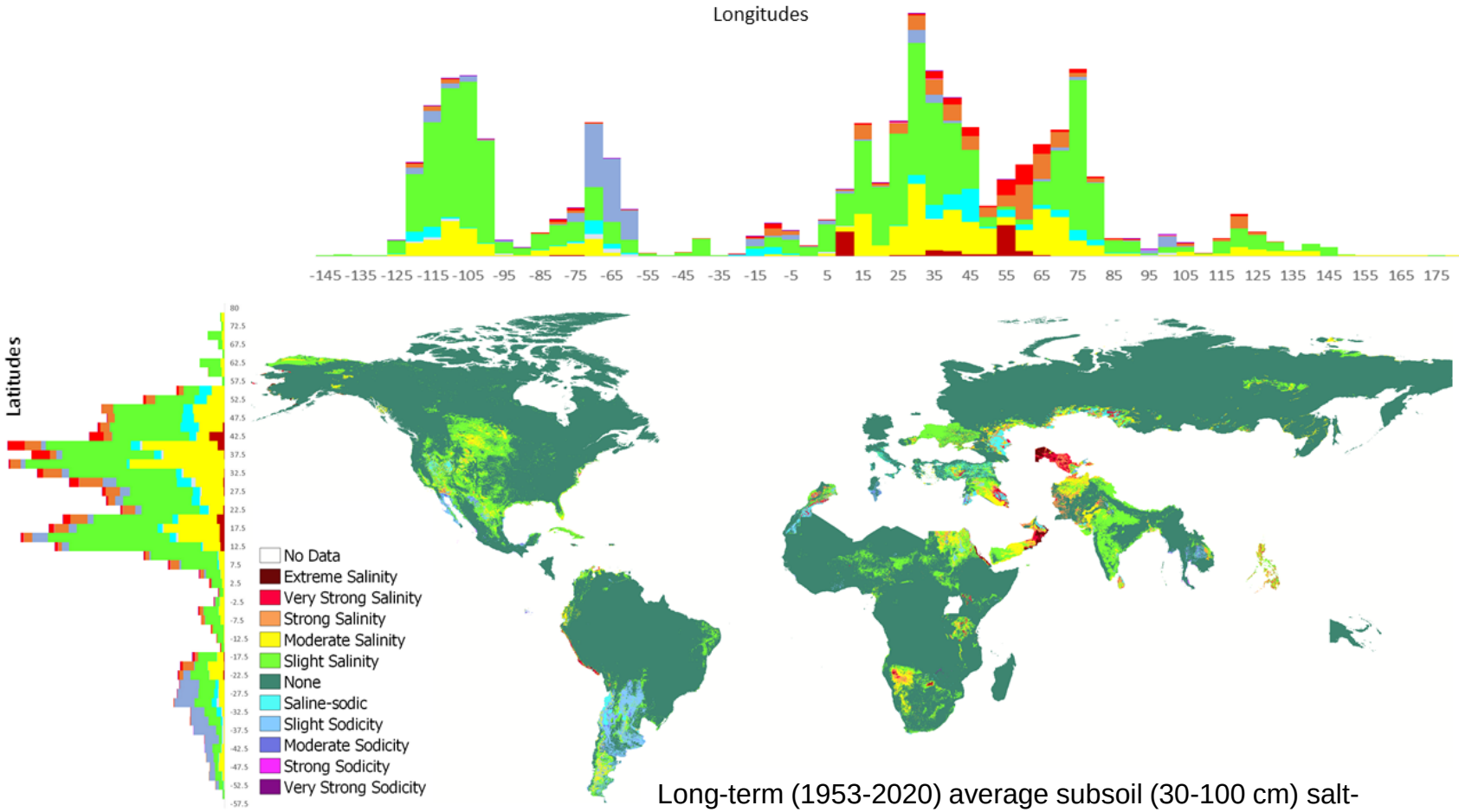
SAS Areas: ≥Moderate Salinity (432 M Ha)

SAS Risk Areas: Slight + Moderate Salinity (994 M Ha)

Key points



SAS Classes	Area (M Ha)	% Subsoil SAS	% Total Land area
Very Strong Sodicity	1.0	0.1	0
Strong Sodicity	1.5	0.1	0
Moderate Sodicity	18.6	1.1	0.1
Extreme Salinity	28.4	1.6	0.2
Very Strong Salinity	50.4	2.9	0.4
saline_sodic	116.1	6.7	0.9
Slight Sodicity	175.1	10.1	1.3
Strong Salinity	119.2	6.8	0.9
Moderate Salinity	323.4	18.1	2.4
Slight Salinity	917.8	52.7	7.1



Long-term (1953-2020) average subsoil (30-100 cm) salt-affected soils

SAS Areas: ≥Moderate Salinity (833 M Ha)

SAS Risk Areas: Slight + Moderate Salinity (1232 M Ha)

Key points

Regional distribution

- Regions with highly salted soils:
  - EURASIA, Near East & North Africa (NENA), and Latin America & Caribbean (LAC)
- Regions with most soils at risk of salt accumulation:
  - Asia & North America

Topsoil (0-30 cm) in M Ha

	=>Moderate salinity	=>Strong salinity	Moderate +Slight	Slight salinity
Sub-Saharan Africa	57.2	20.2	157.8	124.9
North America	21.1	8.1	166.6	150.7
Asia	63.2	13.2	200.6	164.4
Europe	4.4	0.5	45.3	40.7
LAC	74.9	11.1	109.5	68.7
NENA	97.2	23.0	178.1	131.4
EURASIA	105.8	25.9	122.7	45.7
Pacific*	0.0	0.0	0.0	0.0
Total	**423.8**	**102.0**	**980.5**	**726.5**

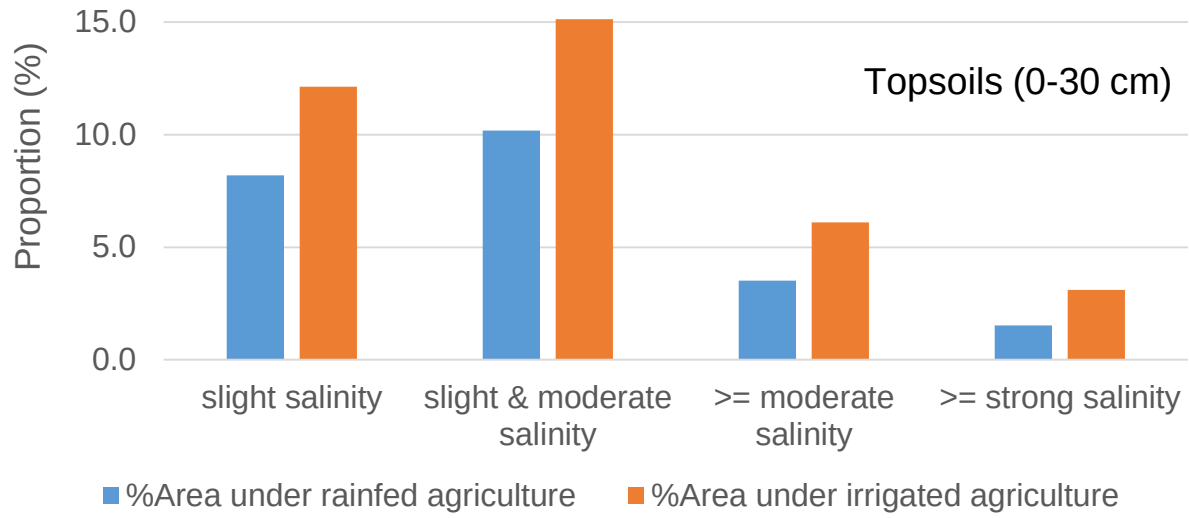
Subsoil (30-100 cm) in M Ha

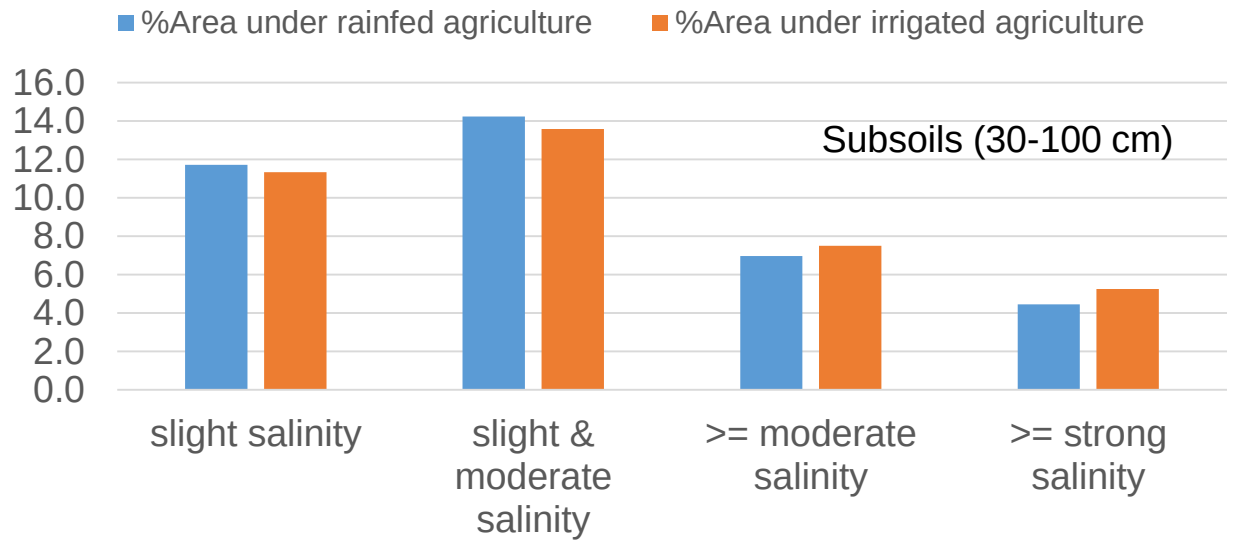
	=>Moderate salinity	=>Strong salinity	Moderate +Slight	Slight salinity
Sub-Saharan Africa	68	22.0	144.3	111.4
North America	48	11.4	365.4	301.6
Asia	120	39.3	212.6	157.7
Europe	11	0.6	7.2	4.4
LAC	227	10.1	163.7	128.7
NENA	176	49.9	160.5	94.9
EURASIA	182	67.1	178.6	119.0
Pacific*	0	0.0	0.0	0.0
Total	**832**	**200.5**	**1232.3**	**917.8**

Key points

For croplands (without mosaics with pasture & tree cover)

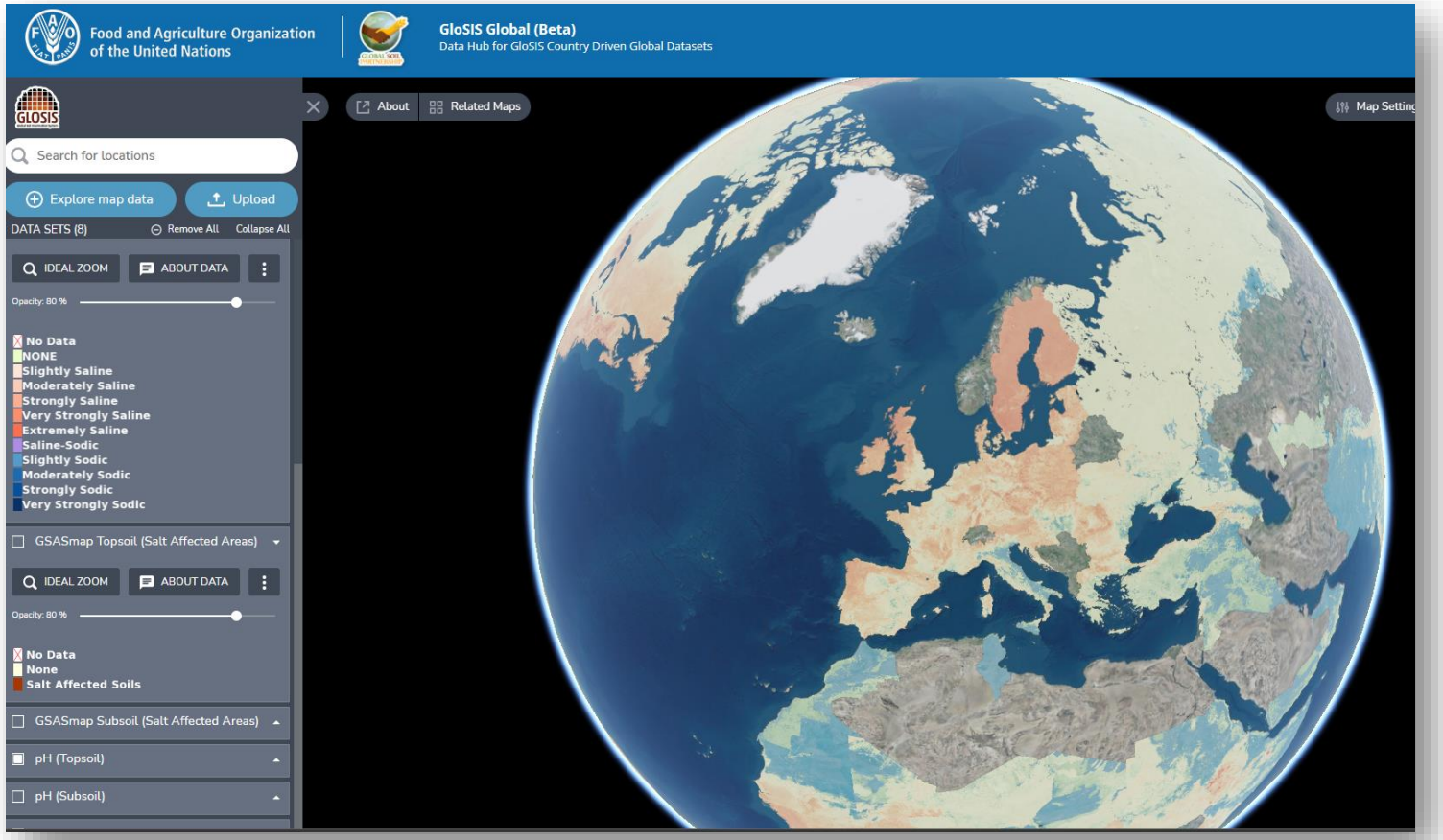
- More than 10% of soils under rainfed croplands are at risk of salt accumulation
- More than 6% of irrigated croplands are too salty





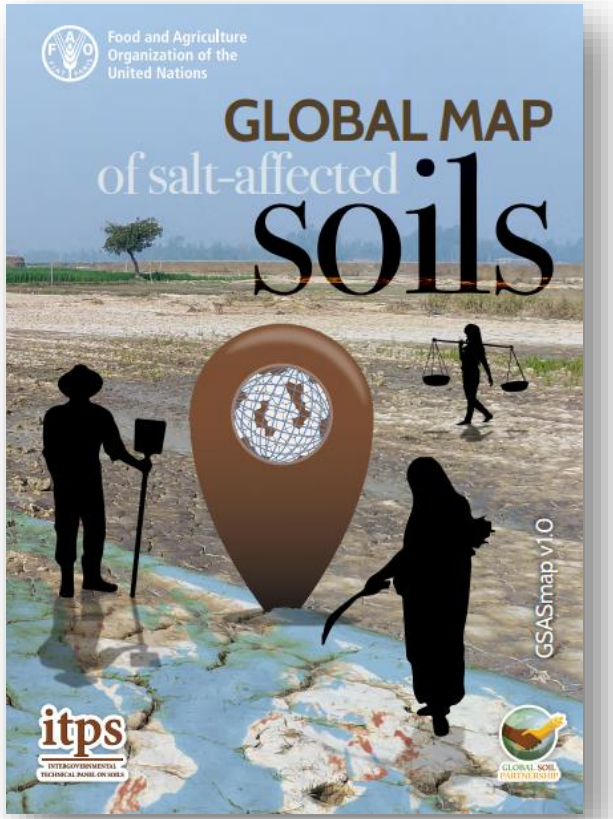
GSASmap – Data Browser

https://www.fao.org/global-soil-partnership/gsasmap/en



GloSIS Global Data Browser

GSASmap Leaflet



Way forward

- Engage INSII members form countries with missing data for filling-in the gaps (Particularly Central Asia, NENA, the Pacific, etc.)

- Develop key GSASmap statistics identifying sustainable soil management practices to be adopted for control of salinization and sodification, conserve natural salt-affected ecosystems, and restoration of areas that had lost their original potential due to salt accumulation.

- Develop update framework for tracking soil salinization and sodification and early detection particularly in agriculture areas.

- The map can support evidence-based decision making for interventions related to agro-food systems, climate change adaptation and irrigation projects.

Acknowledgements

- More than 350 experts from 118 countries who prepared and contributed to the GSASmap

- Technical input and review from GSP Secretariat, ITPS, P4WG, many experts from around the world

- Case study data was provided by the Government of Sudan

- India, Cuba, and Sudan maps were used in demonstrating GSASmap outputs

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