**Global Soil Erosion Map (GSERmap): Country guidelines and technical specifications**

**Food and Agriculture Organization of the United Nations**

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# List of abbreviations

FAO - Food and Agriculture Organization of the United Nations

GLoSIS - Global Soil Information System

GPS - Global Positioning System

GSP - Global Soil Partnership

GSERmap - Global Soil Erosion Map

INSII - International Network of Soil Information Institutions

ITPS - Intergovernmental Technical Panel on Soils

PA - Plenary Assembly

P4WG - Pillar 4 Working Group

RIPs - Regional Implementation Plans

SIDS - Small Island Developing States

SSM - Sustainable Soil Management

SWGSER - Special Working Group on Soil Erosion

UNCCD - United Nations Convention to Combat Desertification

USLE - Universal Soil Loss Equation

WOCAT - World Overview of Conservation Approaches and Technologies

WGS - World Geodetic System

# List of contributors

Soil Information and Data Team (GSP Secretariat)

GSERmap Working Group (GSERmap WG)

Intergovernmental Technical Panel on Soils (ITPS)

International Network of Soil Information Institutions (INSII)

# Summary

This guideline is intended to support countries to prepare data for updating their national soil information on soil erosion and contribute to global soil erosion information. Soil erosion is one of the global challenges in soil resource management, which is linked to land degradation, decline in agricultural productivity, and sediment discharge into waterways and water bodies. Soil erosion due to water, wind, and tillage affects over 1 billion hectares globally and contributes to more than 80% of global soil degradation. This country guideline outlines necessary input data preparation for assessment of these types of erosion at the national level. The guideline focuses on establishment of a national database for modelling water, wind, and tillage erosion as a first step (phase 1) of developing national information on soil erosion. The database is expected to support soil erosion assessment to 1) identify areas affected by water, wind, and tillage erosion, 2) identify management factors to target with erosion control measures, 3) contribute to a harmonized global database for modelling soil erosion.

|  |  |  |
| --- | --- | --- |
| Approach for developing national information on soil erosion | | |
| Approach | Development of national database of soil erosion factors and measured and/or qualitative soil erosion data for modelling soil erosion | |
| Erosion modelling for national scale assessment of soil erosion | |
| Input data preparation (Table 2.3) | | |
| Input data | Climate | Precipitation, Temperature, Wind, Relative Humidity |
| Soil | Sand, Silt, Clay, Organic matter, Carbonate, Bulk density, Structure, drainage |
| Relief | DEM |
| Cover | Land cover, surface stoniness, MODIS (Mod09A) images |
| Management | Soil conservation practices, Tillage intensity, crop residue management |
| Expected outputs | | |
| Outputs | Output 1 | National maps of soil erosion factors for modelling erosion |
| 30 arc-second (~1x1 km) GeoTiff map format in WGS84 geographic projection |
| Output 2 | National maps of soil erosion (dominant types, affected areas, hotspot areas) |
| 30 arc-second (~1x1 km) GeoTiff map format in WGS84 geographic projection |
| Output 3 | Technical report for national mapping of soil erosion |
| PDF document |

# Introduction

## Background

This Country Guideline is intended to guide countries to prepare input data for national soil erosion assessment. It also specifies the expected contributions from member countries towards development of a country-driven global soil erosion information system. The guideline belongs to a family of documents prepared by the Global Soil Partnership (GSP) to support countries in updating their national soil information while contributing to the global soil information.

Soil erosion is a global challenge linked to land degradation, decline in agricultural productivity, and sediment discharge into waterways and water bodies. It is one of the main threats to soil (Montanarella et al., 2016) and an obstacle to the progress towards soil and land related Sustainable Development Goals (SDGs)(Yin et al., 2022). It is also the most widespread and intensively researched threat to soil functions when compared to the other threats such as salinization, sodification, acidification, pollution, organic matter decline, and nutrient imbalance (FAO and ITPS, 2015; Pennock et al., 2019). Despite the attention it draws and its significance in the environment, soil erosion continues to progress at high rates (Borrelli et al., 2021; Bridges, 1992). A symposium organised by the Global Soil Partnership (GSP) in 2019 on global soil erosion identified the challenges contributing to advancing erosion rates and made recommendations for improving actions against the threat (FAO, 2019). This country guideline is a first step towards implementing these recommendations.

Most common types of soil erosion in many countries are water, wind, and tillage. These types of erosion affect over 1 billion hectares globally and contribute to more than 80% of global soil degradation (Bridges, 1992; FAO and ITPS, 2015). Literature information about the methods for their assessment vary depending on the scale of assessment, type and form of erosion addressed, and target application of the assessment results (Báčová et al., 2019; Boardman and Evans, 2020; Morgan, 2005; Pandey et al., 2021). Erosion modelling, remote sensing applications, and expert opinion are some of the assessment methods often used in large spatial scales such as the national, regional, and global levels (Bridges and Oldeman, 1999; Morgan, 2005; Vrieling, 2006). Erosion modelling is the most popular among these large-scale methods. This country guideline is proposing the modelling approach for building consistent national and global soil erosion information.

One of the challenges in soil erosion modelling is access to the recommended input data (Favis-Mortlock et al., 2001). Many countries do not have an organised input database for soil erosion assessment, which contributes to inconsistent national soil erosion information. At the global level and in most regions, consistently updated databases with active contribution from the countries are also scarce (Panagos et al., 2017; Xiong et al., 2019). There is a need to establish soil erosion modelling databases at the national and global levels to support consistent erosion assessment and reporting. Through the Global Soil Erosion map (GSERmap) initiative, GSP aims to support countries to develop soil erosion modelling databases and validation databases for the sub-models of popular large-scale erosion models. This Technical Specifications and Country Guidelines outlines the requirements for developing such a database in a harmonised approach.

## Global Soil Partnership

Global Soil Partnership (GSP) is a globally recognized partnership which was established in 2012 with a mission to position soils in the global agenda through collective action. It provides the forum where global soil issues are discussed and addressed by multiple stakeholders. Over the years, it has strived to fill the global gap in promoting sustainable soil management, awareness campaigns against major soil threats, and coordination of establishment of country-level and global soil information.

GSP is composed of partners, regional partnerships, secretariat, Intergovernmental Technical Panel on Soils (ITPS), and the Plenary Assembly. The partners come from a wide range of institutions such as governmental organisations, universities, civil institutions, research centres, soil science societies, UN agencies, NGOs, private companies, farmer associations, donors, etc. They also include national focal points from the Food and Agriculture Organization (FAO) member countries (<https://www.fao.org/global-soil-partnership/partners/gsp-partners/en/>). Regional Soil Partnerships (RSP) help the GSP to implement its agenda in different parts of the world. They work in close coordination with FAO Regional Offices and establish an interactive consultative process with GSP partners.

The GSP, through its partners and network, can reach different parts of the world with the soil message, coordinated actions on soil information establishment, and awareness campaigns on soil resources. It had initially organised its work around five pillars of actions from the time it was established (Figure 1.1). Currently it’s reforming its activities around 10 areas of work in collaboration with its regional soil partnerships and technical networks (Figure 1.1) (<https://www.fao.org/global-soil-partnership/en/>). Soil erosion is one of these areas of work.

Diagram

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#### Figure 1.1: GSP framework for implementation of its activities

The GSERmap initiative is an initiative within GSP’s Erosion Area of Work, which is focused on improving access to information on global soil erosion, coordinating consistent harmonised assessment and reporting of soil erosion, and promoting actions for halting accelerated soil erosion. The initiative is being implemented by the GSP partners with technical support from a Special Working Group on Soil Erosion (SWGSER) and the ITPS. Its activities are coordinated by the GSP secretariat. The SWGSER comprises members of the International Network on Soil Information Institutions (INSII) and experts from different countries who are actively involved in soil erosion research.

## Objective and scope

The main goal of this country guideline and technical specification is to help countries identify and prepare necessary data for soil erosion assessment that is focused on building national and global soil erosion information. Specifically, the document aims at:

1. Outlining the required input data which countries need to prepare to be able to develop national database for soil erosion assessment
2. Identifying a harmonised approach for building national soil erosion information system
3. Specifying the characteristics of expected outputs from the national levels to be integrated into global information on soil erosion

The document is considering modelling as a priority method for erosion assessment at the national scale. It focuses on the development of a harmonised database for modelling soil erosion to streamline consistent erosion assessment and reporting. Universal Soil Loss Equation (USLE)-based soil erosion models for water, wind, and tillage erosion are preferred as a first step towards mobilising the countries to establish a consistent database for erosion assessment. The database will comprise soil erosion factors for modelling erosion (such as erosivity, erodibility, cover factor, etc.) and data for the validation of sub-models commonly used for quantifying these erosion factors, which include quantitative and/or qualitative data on soil erosion. Countries will need to prepare input data which will be used to develop the national database of erosion factors. The database will later be used in producing national soil erosion information and contribution to global soil erosion information.

# Approach for developing information on soil erosion

## Large-area soil erosion assessment

Many methods exist in the literature for soil erosion assessment (Báčová et al., 2019; Boardman and Evans, 2020; Jarrah et al., 2020; Meinen and Robinson, 2020; Morgan, 2005; Pandey et al., 2021; Vrieling, 2006). Erosion modelling is one of the popular methods often used in large spatial scales. It provides a quick way for characterising soil erosion by integrating data on erosion factors/drivers through quantitative relationships. It is also a convenient method for evaluating effectiveness of erosion control measures (Blanco-Canqui and Lal, 2010; Morgan and Quinton, 2001). Presently there are many models for characterising different aspects of soil erosion (Karydas et al., 2014; Morgan, 2005; Pandey et al., 2016). The models differ in terms of their complexity, purpose and context for their development, input data requirements, time scale, scale of application, types of erosion represented, modelling outputs, among others. Some of these models are shown in Table 2.1.

##### Table 2.1: Popularly used erosion models.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Erosion model | Type of model | | | | | Reference | |
| Erosion | Algorithm | Time scale | Spatial scale |  | |
| USLE/RUSLE | Water | Empirical | Averaged | Field/hillslope | (Renard et al., 1991; Wischmeier and Smith, 1978) | |
| WEPP | Water | Mechanistic | Event | Field | (M. A. Nearing et al., 1989) | |
| MUSLE | Water | Empirical | Event | Field | (Williams and Berndt, 1977) | |
| SWAT | Water | Mechanistic | Averaged | Catchment | (Gassman et al., 2007) | |
| WaterERI | Water | Empirical | Averaged | Field/hillslope | (Lobb et al., 2016) | |
| WEQ | Wind | Empirical | Averaged | Field | (Woodruff and Siddoway, 1965) | |
| RWEQ | Wind | Mechanistic | Both | Field | (Fryrear et al., 2000) | |
| WindERI | Wind | Empirical | Averaged | Field/hillslope | (Lobb et al., 2016) | |
| SLEMSA | Water | Empirical | Averaged | Field | (Smith, 1999) | |
| EPIC | Both | Empirical | Averaged | Catchment | (Williams et al., 1983) | |
| WEPS | Wind | Mechanistic | Averaged | Catchment | (Hagen, 2008) | |
| WaTEM/SEDEM | Water | Mechanistic | Averaged | Catchment | (Van Oost et al., 2009) | |
| TEM/TillERI | Tillage | Empirical | Averaged | Catchment | (Lobb et al., 2016) | |
| TillEM/DirTillEM | Tillage | Mechanistic | Averaged | Field | (Li et al., 2007, 2009) | |
| MMF | Water | Empirical | Averaged | Field | (Morgan and Duzant, 2008) | |
| LISEM | Water | Mechanistic | Event | Field | (De Roo et al., 1996) | |
| EROSION-3D | Water | Mechanistic | Event | Catchment | (Schmidt et al., 1999) | |
| EUROSEM | Water | Mechanistic | Event | Field | (Morgan et al., 1998) | |
| KINEROS | Water | Mechanistic | Event | Catchment | (Woolhiser et al., 1990) | |
| ANSWERS | Water | Mechanistic | Event | Catchment | (Beasley et al., 1980) | |
| AGNP | Water | Mechanistic | Event | Catchment | (Young et al., 1989) | |
| AnnAGNPS | Water | Mechanistic | Averaged | Catchment | (Bingner and Theurer, 2001) | |
| EPM | Water | Empirical | Averaged | Catchment | (Dragičević et al., 2018) | |
| CREAMS | Water | Mechanistic | Event | Field | (Knisel and Douglas-Mankin, 2012) | |
| CSLE | Water | Empirical | Averaged | Field | (Liu et al., 2020) | |
| USPED | Water | Empirical | Averaged | Field | (Mitasova et al., 1996) | |
| SEDD | Water | Empirical | Average | Field | (Ferro and Porto, 2000) | |

Literature reviews on application of erosion modelling show that USLE-based models are the most popular (Alewell et al., 2019; Avwunudiogba and Hudson, 2014; Borrelli et al., 2021; Jarrah et al., 2020). USLE-type models are structured like the Universal Soil Loss Equation (USLE) or use the USLE concept in their models. They include (but not limited to):

1. Water erosion models such as USLE, RUSLE, RUSLE2, MUSLE, USPED, CSLE, SWAT, WATEM/SEDEM, SEDD, CREAMS, AGNPS, EPIC
2. Wind erosion models such as RWEQ, WEQ, WEPS
3. Tillage erosion models such as TEM and TillERI

These models have proven to be useful in identifying agricultural areas at risk of erosion and management factors to target when planning erosion control. They have also been used at large scales to compare erosion susceptibility between areas/regions and raise awareness for action against erosion. Since they are structured like USLE or have USLE concept, they can be implemented with similar input data for developing erosion factor information (Majhi et al., 2021).

## Input data for large-area erosion modelling

One of the challenges in erosion modelling is access to input data. Lack of appropriate databases for modelling soil erosion is negatively affecting consistent national erosion information in many countries (García-Ruiz et al., 2015). Appropriate input database is important for proper model calibration to produce accurate erosion assessment (Batista et al., 2019). Presently, there are few periodically updated regional and global input databases to support soil erosion assessment (Liniger, 2007; Panagos et al., 2017; Xiong et al., 2019).

Input data for large-scale modelling of soil erosion using USLE-type models can be grouped into five categories: climate, soil, relief, soil cover, soil management, and soil erosion data. These categories correspond to the factors of erosion in the erosion models (Morgan and Quinton, 2001; Zachar, 1982).

1. Climate: Climate is one of the main drivers of soil erosion. Climatic data for modelling erosion are rainfall, wind, air temperature, evaporation, and solar radiation. Water erosion models use rainfall data to estimate rainfall erosivity factor (Yin et al., 2017) while wind erosion models use wind, temperature, evaporation and solar radiation to estimate weather factors in the models (Fryrear et al., 2000).
2. Soil: Soil is the eroded material in the erosion process. Erodibility of soil is estimated using input data such as texture, organic matter content, dry aggregates, carbonate content, moisture content, soil permeability and drainage classes, and bulk density. There are many sub-models in the literature for estimating soil erodibility for water, wind, and tillage erosion (Benavidez et al., 2018; Jarrah et al., 2020; Lobb and Kachanoski, 1999).
3. Relief: Relief provides the gradient for moving the eroded soil. It is represented by slope and length of slope parameters. Digital Elevation Model (DEM) is the main input data for estimating slope and length of slope (Hrabalíková and Janeček, 2017; Kruk et al., 2020)
4. Soil cover: Soil cover protects the soil from erosive forces of agents of erosion. Land use and land cover, crop management, surface roughness, and remote sensing images are the main inputs for soil cover characteristics (Benavidez et al., 2018; Fryrear et al., 2000).
5. Soil management: Soil management represents the human influence on soil erosion. It is indexed by soil conservation practices and tillage operations (Hudson, 2015).

A summary of these input data for erosion modelling is given in Table 2.2

##### Table 2.2: Input data requirements for USLE-type erosion models

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Erosion factor category | | | Input data requirements | | Type of erosion | |
| Main | Sub-category |  | |  | |
| Climate | Precipitation | Rainfall amounts and intensities, (I10, I30), snowfall amounts | | Water | |
| Temperature | Averaged air temperature | | Wind | |
| Humidity | Relative humidity | | Wind | |
| Pressure | Air pressure and relative humidity | | Wind | |
| Wind | Wind speed (at 10-m, 2-m) | | Wind | |
| Soil | Texture | Proportions of Sand, Silt, Clay contents | | Wind/Water | |
| Organic Matter | Organic matter content | | Wind/Water | |
| Structure | Calcium carbonate content, dry aggregate, structure class, bulk density | | Wind/water and Tillage | |
| Drainage | Permeability and drainage classes | | Water | |
| Relief | Slope/Length | Digital Elevation Model (DEM) | | Wind/Water/  Tillage | |
| Roughness |
| Cover | Vegetation | Land cover/use types, crop/vegetation types, crop rotation, vegetation/crop management | | Wind/Water | |
| Cover characteristics | Remote sensing images, land cover maps | | Wind/Water | |
| Surface stoniness | | Wind erosion | |
| Management | Erosion control | Conservation practices | | Wind/Water and Tillage | |
| Tillage | Tillage intensity (depth, speed, frequency) and tillage patterns | | Wind, Water/Tillage | |
| Crop residue | Crop residue practices, crop residue type, amount and incorporation | | Wind/water and Tillage | |

# Preparation for national soil erosion assessment and contribution to GSERmap

## Phase I: Developing database for soil erosion assessment

### Preparing input data

Preparing input data is the first step towards development of a soil erosion modelling database. It involves identification of input data (Table 2.2), sources of input data, data collection, and data organization. Table 2.3 describes the required input data in detail.

### Developing erosion database

Erosion database consists of erosion factors (such as erosivity, erodibility, C-factor, topography and management practices, etc.). The database will be developed from the database of input data requirements (Table 2.3). A technical manual and capacity development tools with step-by-step procedure will be developed and shared with countries on how to develop the erosion database. The framework for developing this database is shown in Figure 2.1, which will require the following:

* Prepared national input data (Table 2.3)
* National experts who will be nominated by the countries
* Technical manual and training materials, which will be developed by GSP (SWGSER and ITPS)
* Computing facility (computer and software)
* Workshops to harmonize the procedures

Diagram

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#### Figure 2.1: Framework for data preparation for soil erosion assessment

##### Table 2.3: Input data to prepare for soil erosion assessment

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Data** | | **Data characteristics** | | | | **Data Source** |
| ***Data category*** | ***Require input data*** | ***Units*** | ***Data type*** | ***Timeframe*** | ***Data format*** |
| Climate | Rainfall intensity | mm/hr | weather station data | At least 5-year daily/storm data | Table | National |
| Rainfall and snowfall amounts | mm | weather station data | At least 5-year monthly/annual data | Table/  map |
| Air Temperature | oC | weather station data | At least 5-year monthly data |
| Wind (speed and direction) | m/s, direction | weather station data | At least 5-year monthly data |
| Dust storm/Visibility | Dust events | weather station data | At least 5-year  event/monthly data |
| Relative humidity | % | weather station data | At least 5-year monthly data |
| Kinetic Energy-Intensity relationship | Equation | | | Report | National |
| Erosivity-rainfall relationship | Equation | | |
| Soil | Texture (Sand, Silt, & Clay content) | % | Soil profile data | Recent and/or old soil profile data | Table or soil map | National |
| Organic matter | % | Soil profile data |
| Bulk density | g/cm3 | Soil profile data |
| Carbonate content | % | Soil profile data |
| Structure | categorical | Soil profile data |
| Permeability and drainage | categorical | Soil profile data |
| Soil erosion rates | Ton/ha/yr | Measured erosion data | Recent and/or old data | Table | National |
| Topography | DEM | metres | Elevation map |  | 10-90 m resolution map | National / public\* |
| Cover | Land cover/crop/vegetation cover | categorical | Vector/Raster map | Recent/long-term mean | Map | National or public\* |
| Surface stoniness | Rock cover (%) | Soil surface data/ Vector/Raster map | Recent and/or old soil | Table or soil map |
| Remote sensing image e.g. MODIS (MOD09A) Images | - | Long-term mean image reflectance | 2000 - 2021 | Remote sensing image | Public\* |
| Management | Soil conservation practices | categorical |  | Practice type | Table/map |  |
| Tillage intensity (depth, speed, frequency) and soil disturbance and movement |  | Tillage data | Type of tillage & equipment | Table/map (by crop cover map) | National |
| Tillage depth & speed | Table/map (by crop cover map and tillage implement) |
| Tillage direction | Table/map (by crop cover) |
| Crop residue management |  | Cropping data | cropping patterns | Table/map | National |
| Residue type, amount and incorporation |
| Residue Practices |

Countries will need to: 1) prepare the input data (Table 2.3), 2) nominate national experts to carry out the erosion assessment, 3) organize computer facilities for the exercise. Recommended computing facility should include:

* At least core i5 processor or equivalent
* Computer RAM of at least 8 GB
* Hard disc storage of at least 500 GB
* Internet connectivity

## Phase II: Modelling soil erosion

Modelling of soil erosion is intended to: 1) develop harmonized and consistent information on soil erosion 2) identify management factors affecting soil erosion, particularly in cropland and grassland areas; 3) identify agriculture areas with high erosion potential, and 4) estimate the relative contributions of water, wind and tillage erosion toward total soil erosion.

The process will use the developed national erosion database and identified erosion models for water, wind, and tillage erosion. The technical manual and training materials developed by GSP (SWGSER, ITPS, and GSP Secretariat) will be used to facilitate the modelling. The framework in Figure 2.2 is envisaged to guide the process and produce a national map of soil erosion and management factors to target in erosion control.

Diagram

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#### Figure 2.2: Framework for national scale modelling of soil erosion

Development of national soil erosion information will require a national database of soil erosion factors (output 1 in Figure 2.1). It will be supported with technical documents (e.g., technical manual and capacity development materials), which will be developed by the SWGSER and ITPS.

# Product specification and delivery

## Expected outputs

The following products are expected at the country-level contribution to the global soil information on soil erosion:

1. **Input data base**: National database of input data for developing soil erosion factors that are needed for modelling water, wind, and tillage erosion: This is a GIS database of maps, spreadsheets, and published information if available.
2. **National database of erosion factors**: National database of soil erosion factors:
   1. Water erosion: rainfall erosivity, soil erodibility, slope-length, cover, and practice factors
   2. Wind erosion: climate, erodibility, crusting, roughness, and crop factors
   3. Tillage erosion: tillage erosivity, landscape erodibility
3. **National soil erosion information**: National soil erosion information consisting of maps of soil erosion (potential areas affected by water, wind, and tillage erosion), management factors to target with erosion control measures, and estimate the relative contributions of water, wind and tillage erosion toward total soil erosion
4. **Technical report**: Technical report detailing input data, national soil erosion assessment, and management factors to target in erosion control.

GSP (SWGSER and ITPS) will prepare a global technical report (Global Status of Soil Erosion) and scientific publication with contributions from the national teams.

## Product delivery and specifications

After completing development of national soil erosion information, countries are expected to contribute to the development of global soil erosion information. The countries will retain the copyright of the primary input data (such as rainfall, soil properties, etc.) but contribute the finished products (such as erosivity, erodibility, etc.) for the development of global information. The contributions will be submitted to FAO through a standard link that will be shared between FAO and the submitting countries. This section describes the expected products to be delivered and their specifications to ensure compatibility of contributed products from all countries.

### Phase I: Maps of soil erosion factors

1. **Mandatory and optional products to deliver**
2. Mandatory products:
   1. 5 water erosion factor maps: rainfall erosivity, soil erodibility, slope-length, cover, and practice factors
   2. 5 uncertainty maps of water erosion factors: rainfall erosivity, soil erodibility, slope-length, cover, and practice factors
   3. 5 wind erosion factor maps: weather, erodibility, crusting, roughness, and crop factors
   4. 5 uncertainty maps of wind erosion: weather, erodibility, crusting, roughness, and crop factors
   5. 3 tillage erosion factor maps: tillage erosivity, landscape erodibility
   6. 3 uncertainty maps of tillage erosion factor maps: tillage erosivity, landscape erodibility
3. Optional products: Validation points (measured soil erosion rates and identified erosion hotspots), published reports, and primary input data (e.g., rainfall, soil properties, etc.)
4. **Specifications and format**

The contributed geospatial data will be:

* Square tiles of 30 by 30 arc-second grids (approximately only 1x1 km at the equator) covering the national boundary.
* In World Geodetic System (WGS) 1984 geographic (decimal degrees) projection.
* In geoTiff format. GeoTIFF is a standard .tif or image file format that includes spatial (georeferencing) information embedded in the .tif file as tags.

### Phase II: Soil erosion information

1. **Mandatory and optional products**
2. Mandatory products
   1. National water erosion map (showing erosion rates)
   2. National wind erosion map (showing erosion rates)
   3. National tillage erosion map (showing erosion rates)
   4. National map of management factors to target with water erosion control measures
   5. National map of management factors to target with wind erosion control measures
   6. National map of management factors to target with tillage erosion control measures
3. Optional products: validation points, published reports

### Timeline and product delivery

Phase I products are expected to be delivered by December 2022

Phase II products are expected to be delivered by May 2023

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