Soil Erosion Prevention from Croplands- A Service or A Disservice?

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Outline

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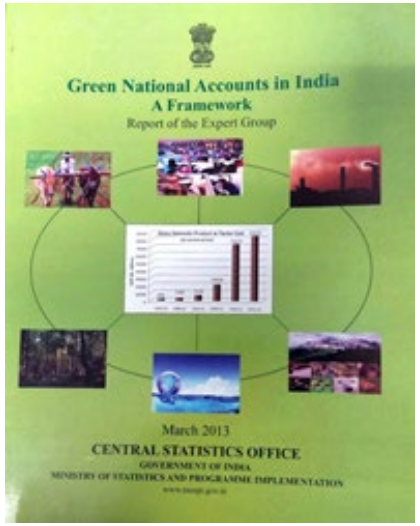
Environment Accounts in India

Ministry of Statistics and Programme Implementation has the mandate for:
'Development of Environment Statistics, development of methodology, concepts and preparation of National Resource Accounts for India.'



1997-2009

Different studies conducted under the aegis of Technical Working Group on NRA. Studies- disparate in nature – a strategy was required

2011

Expert Group under Prof. Sir Partha Dasgupta constituted for preparing roadmap

2013

Expert Group released report, "Green National Accounts in India-A Framework" and recommended compilation of the SEEA accounts in phased manner

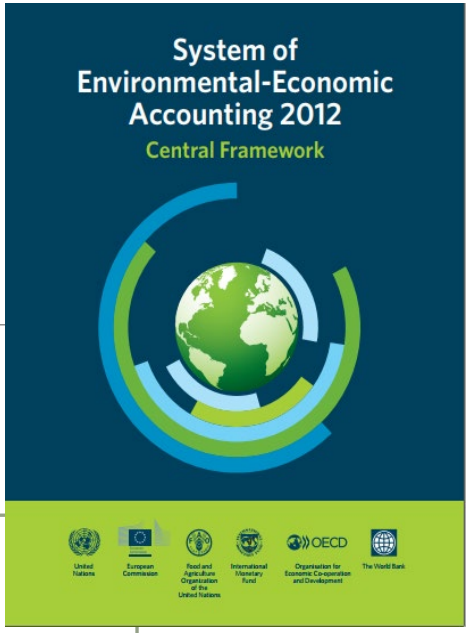
2016

Inter-Ministerial Group (IMG) constituted

SEEA Ecosystem Accounting

India adopted SEEA in 2018 and has been regularly publishing accounts since then.

- Extent
  - Forest
  - Land
- **Condition**
  - Forest Condition Accounts
  - Soil Nutrient Index
  - Wetland Condition Accounts
  - Cropland Condition
  - Water
- **Services**
  - Provisioning Services
    - Timber Provisioning
    - NTFP Provisioning
    - Crop Provisioning Services
    - Fish Provisioning Services
  - Regulating Services
    - Carbon Retention Services
    - Soil Erosion Prevention Services
  - Cultural Services
    - Nature Based Tourism Services



Soil Erosion

- Soil erosion is a gradual process that occurs when the impact of water or wind detaches and removes soil particles, causing the soil to deteriorate.
- The loss of soil from land surfaces by erosion is widespread and reduces the productivity of a number of ecosystems including croplands and forests.
- Soil erosion in terrestrial ecosystems, as an important global environmental problem. It has several negative impacts:
  - Loss of arable land
  - Affects yield production
  - Affects plant growth
  - Pollutes nearby waterbodies through sediment runoff
  - Increased risk of floods

Soil Erosion Prevention (SEP) Services

- One of the fundamental ecosystem services of vegetation cover.
- Quantification of SEP:
  - Estimation of the ‘soil erosion prevention services’ is based on a counterfactual scenario of ‘no service supply’ in the base line.
  - The approach suggested in SEEA, compares actual erosion rates to those for bare land where the erosion rate in bare land is the maximum potential erosion rate (a worst-case scenario) in a given ecosystem, allowing for soil type and erosivity, slope characteristics, rainfall characteristics and land management factors.
- Service supply is defined as the reduction in erosion rates compared to bare land and the baseline needs to be bare land since it represents the situation in which there is no ecosystem service supply.

SEP of Croplands: Service or Disservice?

- Croplands are being converted from fertile lands such as forests to fulfil the needs of the growing population and had it not been the cropland there would have been natural vegetation on that land, which could have prevented soil loss to a large extent.
- The LULC dynamics in India shows that
  - 2015-16: The forests and barren lands are the biggest contributor to additional land added to croplands
    2011-12: Cropland have maximum share in land use converted from erstwhile Forest.
- FAO study at global level suggests
  - Forest has maximum share amongst the other land use categories converted to croplands
- Therefore, It would not be fair to assume bare land as baseline while quantifying SEP of croplands.

SEP of Croplands: Service or Disservice?

- To quantify the actual soil erosion prevention service of any ecosystem, it is important to determine what category is considered as baseline land cover.
- For Croplands, following baseline scenarios have been considered:
  - Bare Land
  - Forest
  - Scrubland
- These scenarios are compared and analysed to see if the ‘prevention of the soil erosion’ service provided by the croplands is a service or a disservice as the baseline scenario changes.

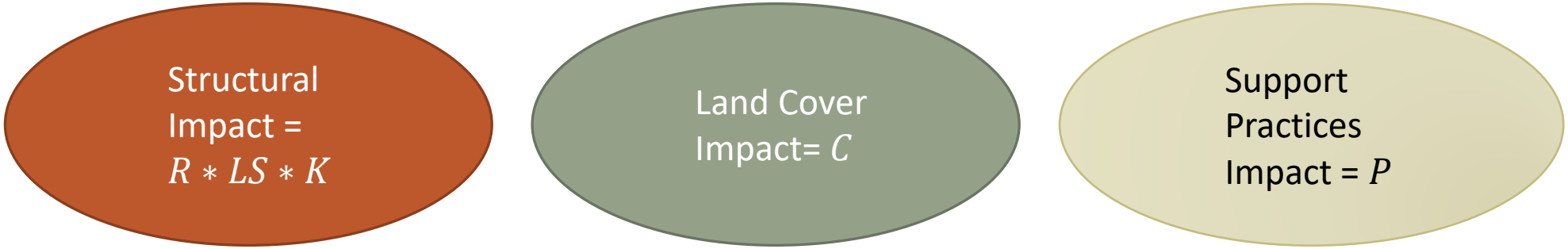
Methodology

- Quantification of Soil Loss: The revised universal soil loss equation (RUSLE), an empirical soil loss model is frequently used model to estimate soil loss.

$$\boldsymbol{A = RLSKCP}$$

where A is mean annual soil loss (metric tons per hectare per year), R is the rainfall and runoff factor or rainfall erosivity factor (megajoule millimetres per hectare per hour per year), K is the soil erodibility factor (metric ton hours per megajoules per millimetre), L is the slope length factor (unitless), S is the slope steepness factor (unitless), C is the cover and management factor (unitless), and P is the support practice factor (unitless).

- In the RUSLE model, the structural and land cover impact is represented by several factors.



Methodology…

Terminology

Land Cover	C Factor	Soil Loss	Soil Erosion Potential
Bare Land	C	$SL = R * LS * K$	Maximum (C=1)
Cropland	C_C	$SL_C = R * LS * K * C_C$	Less
Forests	C_F	$SL_F = R * LS * K * C_F$	Lesser

To quantify SEP of Croplands, two cases:

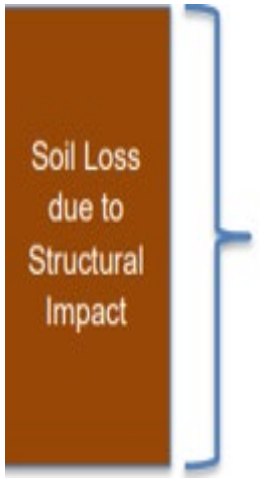
Baseline is bare land: Soil loss in croplands subtracted from soil loss in bare land

Baseline is Forest: Soil loss in croplands subtracted from soil loss in forests

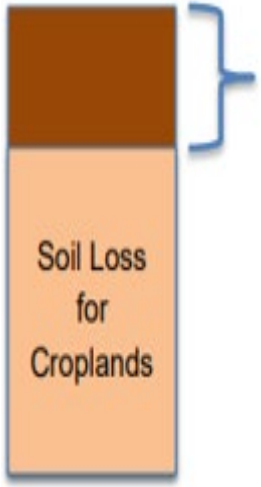
Methodology…

Literature review shows that $C_F < C_C < C$

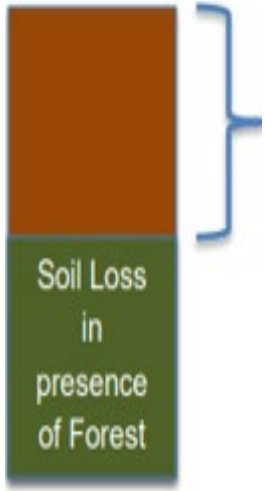
This implies $SL_F < SL_C < SL$



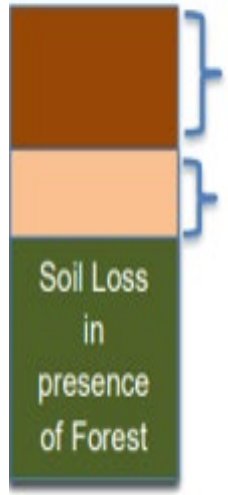
Soil Loss due to Structural Impact (Bare Land)



Soil Loss mitigated due to cropland when baseline is bare land



Soil Loss mitigated due to Forests

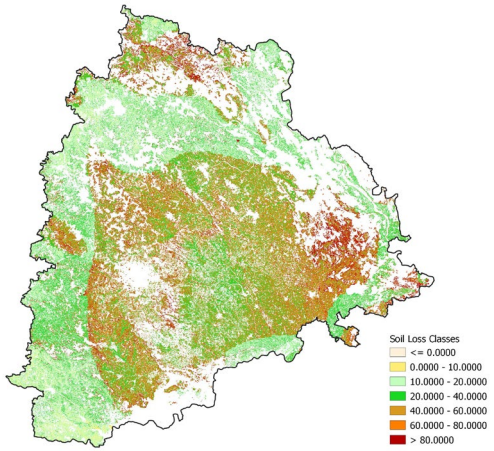
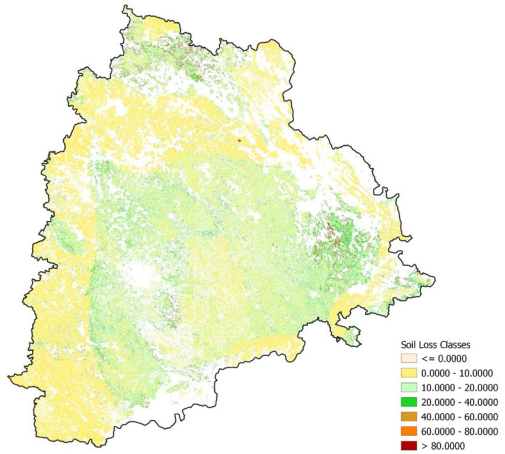
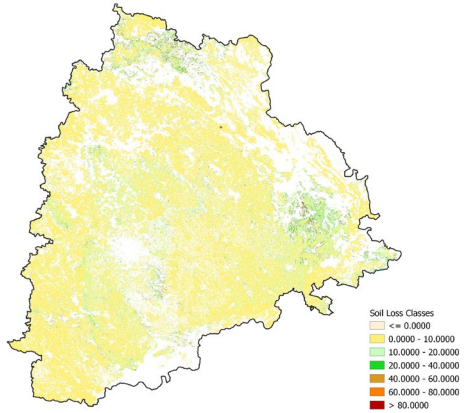
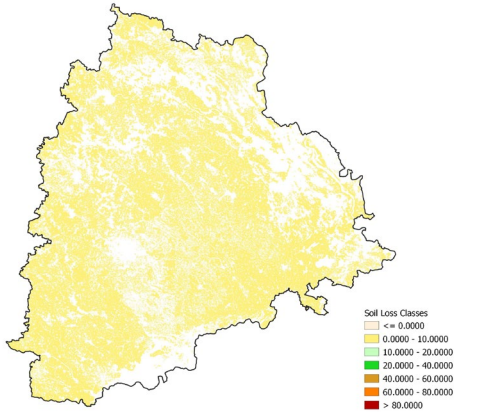


Soil Loss mitigated by Croplands when baseline is bare land

Soil Loss due to croplands when baseline is Forests

Results

Spatial Distribution of Soil Loss under Different Land Use categories

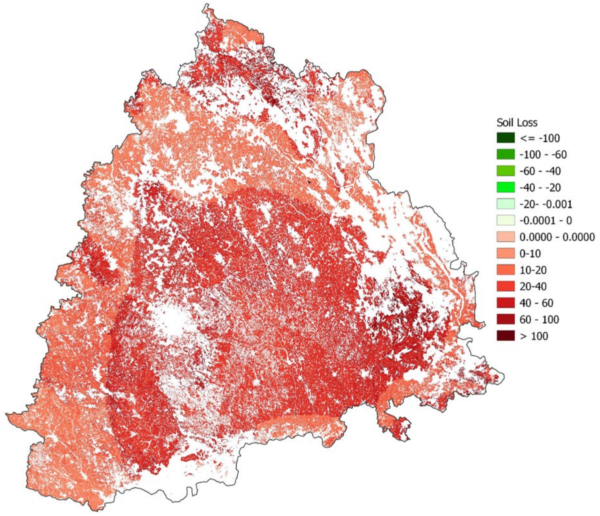
Soil Loss: Bare Land	Soil Loss: Croplands	Soil Loss: Scrubland	Soil Loss: Forests
			

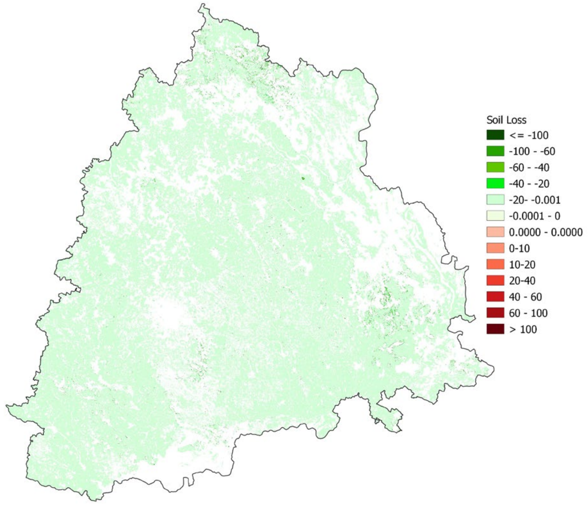
- Soil Loss is observed to be maximum in Bare Lands, followed by Croplands, Scrublands and Forests respectively.

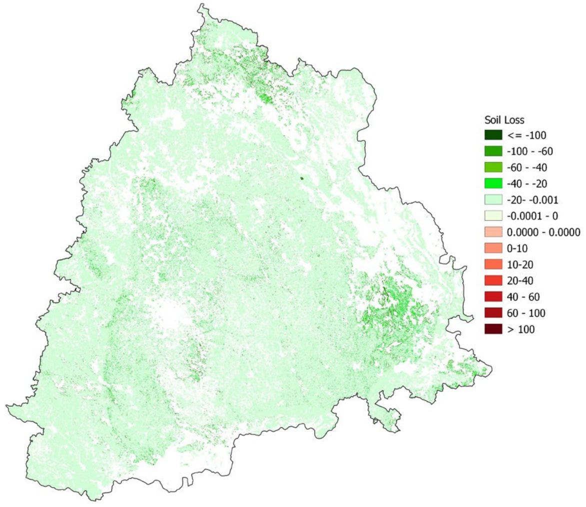
Results…

Spatial Distribution of Soil Erosion Prevention Services under different Scenarios

SEP when baseline: Bare Land	SEP when baseline: Scrubland	SEP when baseline: Forests







Red color denotes positive difference in soil loss in baseline and soil loss due to croplands while green denotes negative difference.

When Baseline is forest and scrubland, the difference is negative, which denotes soil loss added due to croplands and this is a disservice of cropland ecosystem.

Limitations

- Hilly areas: It is observed in several studies that in certain areas in India particularly in the hilly areas, the Soil loss in croplands is less than Forests
- Incorporation of P factor: For this study, impact of P factor has not been considered.
- Limitations of RUSLE model:
  - Uncertainties associated with the model- in few cases, it gives overestimated values of Soil Loss
  - Uncertainties associated with upscaling the model to a larger area

Conclusion

- It is crucial to have the precise knowledge about the land use land cover before deciding on the appropriate baseline land cover.
- The baseline land cover cannot be universally decided as there are plenty of other factors such as the changing dynamics of land over time, the management practices available, the vegetation that formed a part of the barren land etc.
- The LULC dynamics may help in identifying the land cover/ecosystem which contributes maximum to the converted land cover ecosystem.
- The subject ‘environment’ encompasses several ecosystems and the assets are interrelated with each other. In order to arrive at a just and robust conclusion, all the dimensions and their possible inter-linkages needs to be borne in mind.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