



Food and Agriculture  
Organization of the  
United Nations

# GSP Pillars Updates and the Way Forward: Regional Database on Soil R&D

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**7<sup>th</sup> NENA Soil  
Partnership  
Meeting**

22-23 March 2022



**NEXUS**  
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AmirKabir University Foundation



GLOBAL SOIL  
PARTNERSHIP



# Soil Nexuses R&D&I&S Database Proposal A Global DSS Scope with A Regional Pilot for NENA (First Submitted in 2015)



- Natural resource limitations
- Planetary ecological boundaries
- Securing the sustainability of life on this planet
- Achieving 2030 Agenda and combatting the global warming
- Science-based policy development



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# Scopes to be Covered



- Pure research,
- Applied research,
- Experimental development and
- All other research which may not fall into either of the above categories,
- R&D institutions
- R&D scientists
- R&D output documents, reports, papers, theses, etc.

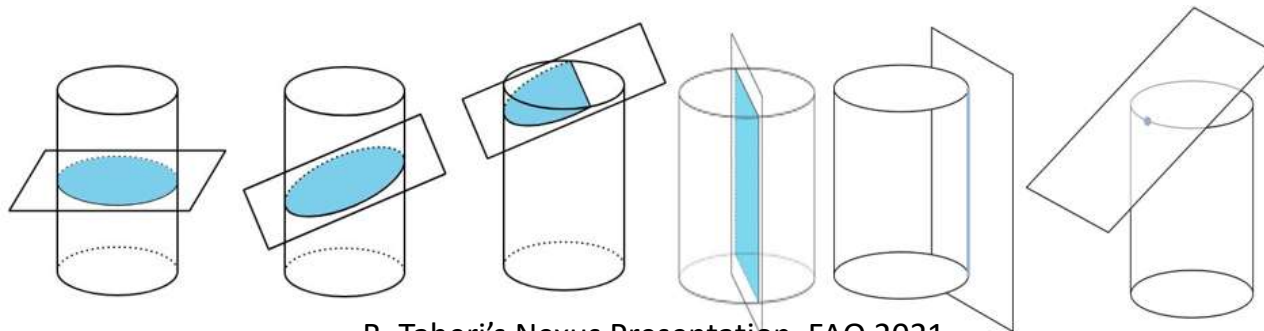
# Disparities and misunderstandings



- Geographical
- Topical (Soil)
- Interdisciplinary (Soil & .....

**“You think because you understand 'one' you must also understand 'two', because one and one make two.**

**But you must also understand 'and'.”**



B. Taheri's Nexus Presentation, FAO 2021

**From Rumi, the Persian poet**

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# Shares and Trends of Global R&D Expenditures in 2017



## Share of Total Global R&D Spending

	2016	2017	2018
North America (12 countries)	27.52%	27.60%	27.36%
United States	25.36%	25.60%	25.25%
South America (10 countries)	2.44%	2.40%	2.28%
Europe (34 countries)	21.16%	21.00%	20.52%
Germany	5.60%	5.50%	5.32%
Asia (24 countries)	42.72%	42.67%	43.62%
Japan	9.00%	8.80%	8.52%
China	20.70%	21.20%	21.68%
South Korea	4.00%	4.10%	4.03%
India	3.60%	3.70%	3.80%
Africa (18 countries)	0.88%	0.90%	0.92%
Middle East (13 countries)	2.43%	2.50%	2.51%
Russia/CAS (5 countries)	2.86%	2.90%	2.80%
<b>Total (116 countries)</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

Source: R&D Magazine Survey 2017

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# Global R&D Expenditure



- global research and development (R&D) investments “will increase 4.14% in 2018 to \$2.190 trillion in purchasing power parity (PPP) values for the 116 countries having significant R&D investments (more than \$20 million).
- This expenditure is against 105 trillion dollars of PPP global GDP in 2018 and shows an approximate measure of 2% of GDP R&D expenditure with a global rate of increase in excess of global economic growth, estimated at 3.5 % according to IMF



# Disparities! Who is Doing What?

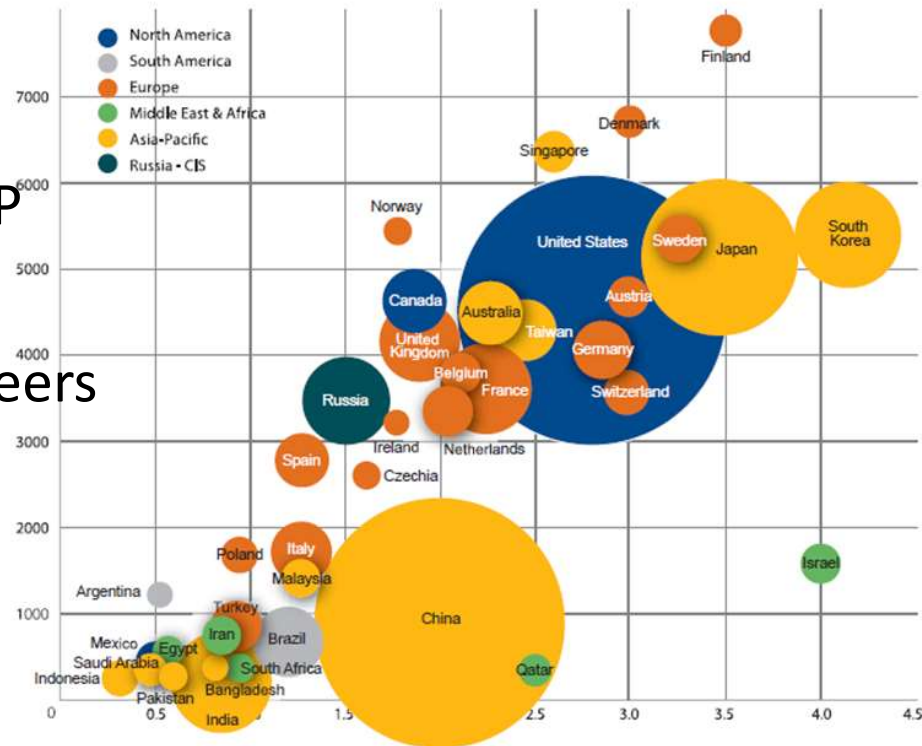


- Horizontal:

R&D as % of GDP

- Vertical:

Scientists/Engineers  
per M people



Source: R&D Magazine, World Bank, International Monetary Fund, CIA Fact Book, OECD

The size of the circles in this Chart reflects the relative amount of annual R&D spending by the indicated country. Note the regional grouping of countries by the colors of the balls. The horizontal axis reflects R&D spending as a percent share of the countries' GDP (gross domestic product). The vertical axis reflects the number of researchers (including scientists and engineers) per million population for the respective countries.

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# Hints and Values



- Analysis of the share of different fields of active global R&D is very difficult due to lack of robust, well-structured and smartly-architected database. However, the problem is not only related to software aspects, it is also related to **terminologies, methodologies and technologies** which need **harmonization**.
- For example, deciding upon **what really constitutes a soil research** or a soil development topic is a pivotal question in creating the database, which does not garner the same answer even among the soil specialists. Furthermore, the answer to this question **is not fixed in time** and a responder's view on that is definitely different today from 20 years ago.
- We will definitely need to include a much wider range of research and development in our database, in particular when it comes to the interdisciplinary and nexus issues. There are many research topics which are being conducted on water which have vitally important outcomes for soil. Equivalently, many research areas related to climate change, food, environment and energy have the same attributes as above.
- From this point of view, even if we presume that only **2% of the, above mentioned, R&D** expenditure has been related to soil and its nexuses, we are pointing at a wealth valued in excess **of one trillion dollars**.



# One trillion dollar questions are:



- How well we have utilized the created knowledge and science related to soil?
- How well we have provided access to others to use this wealth of knowledge?
- How successfully we have avoided repetitive research and development, not only globally, not only regionally, but also nationally?
- How well we have created the needed synergy between two concurrent research projects, or between an already completed research and an ongoing one?
- And how well we have directed the newly allocated research budgets in direction of national, regional and global R&D needs and priorities?

# Answers and the Way Forward



- Of course, the sequence of these questions can continue and it is exactly these questions which should define the **spirit of the logic and algorithms behind creation of this database**, which should become instrumental **as a DSS** not only in answering the strategic set of questions, but also act as an engine which facilitates and encourages **national, regional and global cooperation** and collaboration, **not only among the soil scientists**, but also among the researchers who can add value to each other's research and development through **nexus collaborations**





## Cost of soil Research



- In the paper, “A Soil Science Renaissance”, published in Article in Geoderma, Alfred E. Hartemink, Alex McBratney, December 2008, it is estimated that almost **1% of the global R&D expenditure is on soil**.
- Of course, they have not considered the nexus interconnections between and among the elements.
- They have estimated that the **cost of supporting 16,000 soil scientists** in the OECD region is around **3.2 billion dollars** and comparing the number with around 16,000 soil papers published in the OECD, they have estimated that the cost of **publishing a soil paper is around 200,000 dollars** compared to the general estimation of **700,000 dollars per paper in the USA and 300,000 USD in Canada** and Latin America.

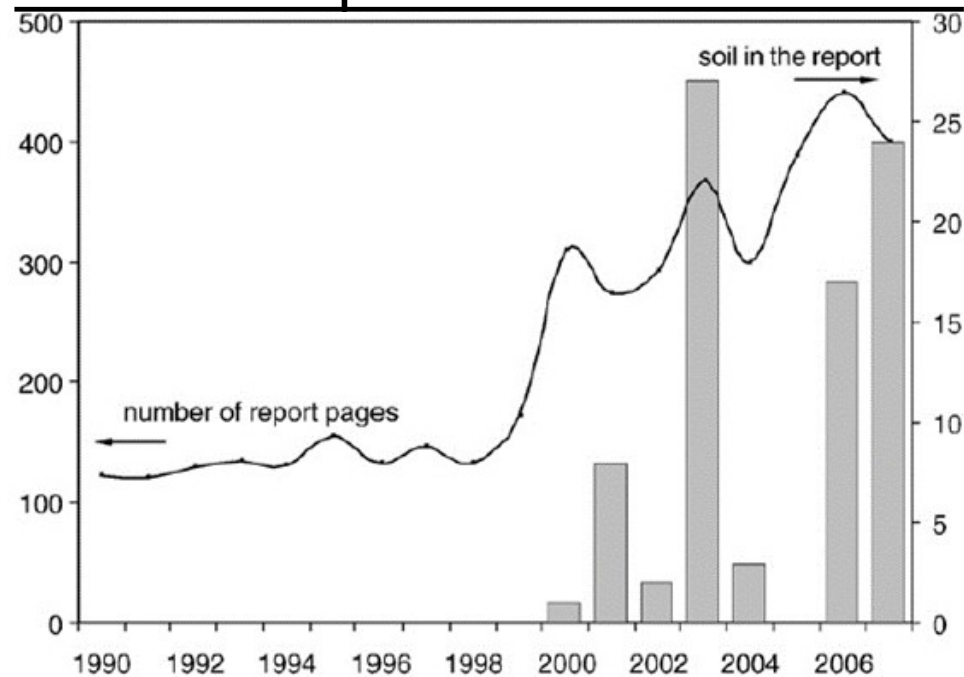
# Disparities



- One of the conclusions of the report is that **FAO is in crisis** and has **very few areas left in which it has technical leadership, which includes land and soils.**
- Yet, an **area of comparative priority** is the **provision of basic global natural resource data and statistics including land and soils.**
- The **review gives land and soils the highest priority for resource allocation** (above, for example, water and irrigation or crop production and processing technologies).
- The report justifies it as follows: “There can be no doubt **of the pressure put on land resources** by increasing population, demand for increased supply of agricultural products, urbanization and climate change. National land management is a technical, economic and social issue and addressing it requires basic information.



# Frequency of using the word “Soil” in UN reports after 2000

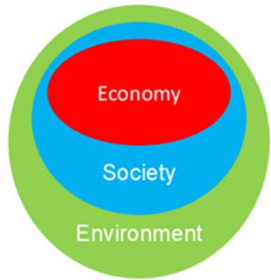


**Before 2000, soil was not among the topics covered under the Human Development Index**

# Issues of Importance



- **All the soil-related R&D projects**
- **Exclusivity** of the categories and classes
- **Comprehensiveness** and **universality** of the categories defined
- Terminology
- Methodology of acquiring data and information
- Consistency across countries and in time
- **interconnectivity and communication** between this database and other related databases within GSP, FAO and other national, regional and global organizations
- Providing possibility of higher orders of analysis



## Some of the Goals of Developing the GSP-NENA Up-scalable Soil R&D&I&S



- Promote **targeted soil research and development**, focusing on identified **gaps, priorities and synergies** with related productive, environmental and social development actions.
- Compile **evidence of socio-economic return** on investment in soil research, stressing importance of soil functions and **focusing on all the direct, indirect and hidden aspects of cost-benefit**
- Encourage and facilitate **inter and trans-disciplinary research** and development (R&D) of SSM practices and systems
- Capitalize on **already completed R&D** and **existing body of knowledge** on **national, regional and global** levels
- Capitalize on **existing R&D research initiatives** and outputs

# Some of the Goals of Developing the GSP-NENA Up-scalable Soil R&D&I&S



- Identify regional and local priorities
- Provide information for the global research and end-user communities on potential repetitive research agenda, while facilitating and streamlining local capacity building
- Identify the synergies with the global soil research initiatives
- Foster synergy and engagement between research and end-user communities and donors
- Foster green business, climate change mitigation/adaptation and UN HDI development related to soil



# Activities (2018-2022)



## 1. Develop a global soil research internet platform (multi-device accessibility)

### a. Develop and provide an inventory of global, regional and national

- Soil research partners
- Soil research facilities and infrastructure
- Soil research programs, including budgets
- Soil research gaps
- Soil research overlaps
- Repetitive soil research programs (no new added value)
- Soil research project topics, completed (applied and non-applied, university/non-university, government/private/international agencies, etc)

# Activities (2018-2022) Continued



## 1. Develop a global soil research internet platform (multi-device access possibility)

### a. Develop and provide an inventory of global, regional and national

- Provide a data bank for research conducted in languages other than English, if a one page English abstract and key-words are provided by submitting parties, so that a search through abstract can still be conducted.
- Soil Studies, virtual library
- Soil research staff and human resources
- Soil related academic programs, universities, institutions (Government/Private)
- Soil sciences and engineering professors (male/female)
- Soil sciences and engineering students (M/F, PhD/MS/BSc)
- International, regional and national public/private Soil R&D funds and resources

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# Activities (2018-2022) Continued



1. Develop a global soil research internet platform (multi-device access possibility)
  - b. Share all products developed through research activities on this platform for easy access to all stakeholders
  - c. Provide multiple search possibilities and a complex search engine to accommodate multiple logical combinations for users
  - d. Provide dialogue possibility and different Fora for platform users
  - e. Provide Q/A possibility on the site
  - f. Create a Soil Nexuses platform on development of science and R&D
  - g. A data bank of budget providers and donors (Private/Government/International)
  - h. Create a General Soil library perhaps limited to non-copy righted books and articles (A point of possible contention, but worthy of consideration)

# Activities (2018-2022) Continued



2. Assess existing soil R&D initiatives, identify global research priorities.
  - Develop inventory of existing soil research initiatives, facilities, capacities, infrastructure and outputs
  - Identify, global and regional R&D priorities based on national and regional needs and priorities
  - Consider global targets of SDGs, UNCCD, UNFCCC, CBD and UN HDI
  - Consider priorities identified through all GSP networks, e.g. INSII, GLOSOLAN, GLOSIS, INBS, etc.





# Activities (2018-2022) Continued



## 3. Encourage nexus, inter and trans-disciplinary R&D and develop regional and global soil R&D Roadmap

- Develop regional soil research platform through regional soil partnership
- Enhance existing regional platforms
- Facilitate coordination of soil R&D and policy support
- Ensure collaboration with other disciplines
- Develop research project proposals
- Integrate nexus approach into soil R&D roadmap
- Facilitate and encourage development of national soil R&D roadmap
- Develop and suggest soil regional and global R&D Roadmap
- Launch targeted R&D programs

# Activities (2018-2022) Continued



## 4. Highlight return on investment in soil R&D

- Identify and develop indicators with defined harmonized and standardized methodologies to assess economic cost of soil degradation and the value of its rehabilitation
- Address and improve upon ITPS study on benefits of SSM using the capabilities acquired through development of the DB
- Develop region-specific models to assess costs and benefits, addressing direct, indirect and hidden components
- Encourage science-based decision making and policy development by creating needed methodologies and processes
- Convey results to decision makers
- Create methodologies for socio-economic assessment of investment in soil R&D
- Assess national investment in soil R&D and return on investment
  - Include MER and PPP values
  - Identify funds from governments, private sector, international grants UN sponsored

# Activities (2018-2022) Continued



## 5. Develop active collaboration between research bodies and other stakeholders

- Identify key stakeholders and potential donors to address research priorities
- Promote multi-stakeholder discussions to share knowledge for launching joint projects
- Promote systemic contacts and cooperation between research bodies and national, regional and international policy makers
- Organize global symposia, such as GSOC, GSOP, Soil Nexuses, etc.



# Categorization of Soil Research Areas

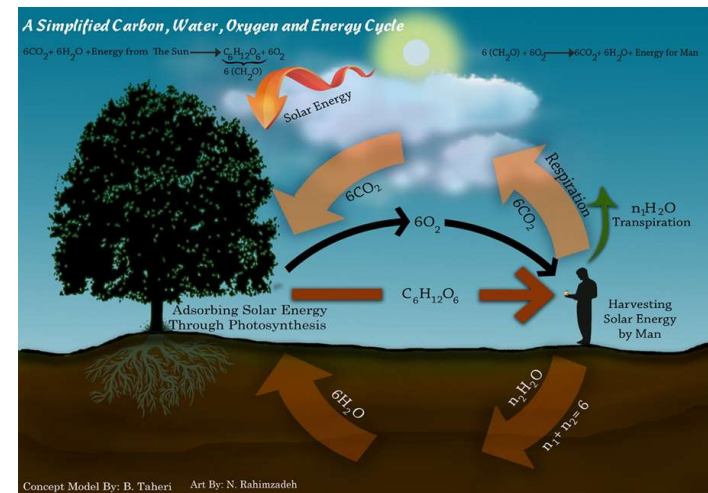


- Elements emphasized in VGSSM
- SDG, any interconnections identifiable with the 17 SDG goals and 169 targets and underlying indicators (This can be expanded further in the next version of the proposal, so that through the Soil Sciences and R&D Database, we can facilitate definition and creation of methodologies for new indicators and sub-indicators related to soil for every goal and target as relevant.
- UNFCCC/adaptation/mitigation/resilience (this can also be expanded and address more details on soil capacity in adaptive measures, mitigation potentials, resilience improving and interdisciplinary climate research and projects addressing multiple co-benefits)
- GSP Pillars (under each of the 5 pillars, through interconnections with SSM goals)
- Soil nexuses

# Soil Nexuses, 2-D Space



- Soil and water
  - Different types of soils vs different types of water
- Soil and energy
- Soil and climate change/variability (Adaptation, mitigation and resilience)
  - Soil & carbon
  - Soil MRV
  - Soil adaptive management
- Soil and environment
- Soil and ecosystem/ecosystem services



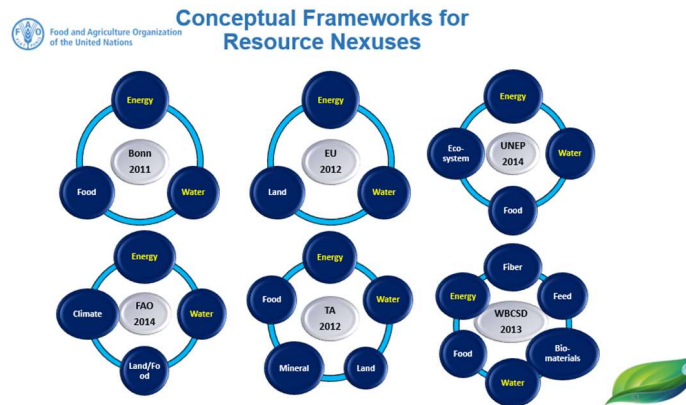
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# Soil Nexuses, 2-D Space



- Soil and ecosystem/ecosystem services
- Soil and food
- Soil and farming (smart farming, organic and non-organic)
- Soil and greenhouses
- Soil and health
- Soil and society
- Soil and economy
- Etc.



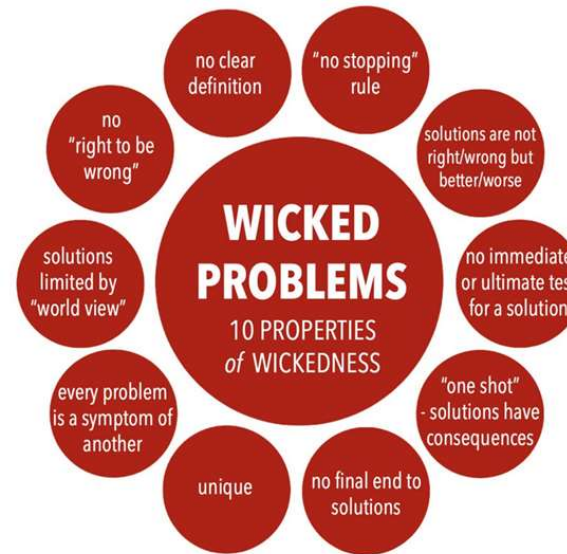
B. Taheri's Nexus Presentation, FAO 2021



# Soil Nexuses, 3-D Space and Higher Orders



- Soil-Water-Food
- Soil-Water-Energy
- Soil-Food-Energy
- Soil-Water-Environment
- Soil-Carbon-Water
- Soil-Carbon-Climate Adaptation
- Soil-Carbon-Climate Mitigation
- Soil-Carbon-Food
- Soil-Water-Food-Climate Adaptation (4-D)
- Soil-Water-Energy-Food-Climate Adaptation-Climate Mitigation-Society (7-D)
- Etc.



adapted from: Dilemmas in a General Theory of Planning  
Horst W.J. Rittel and Melvin M. Webber (Policy Sciences, June 1973)

# Elements emphasized in VGSSM



- The types of ecosystem services and the soil functions referred:
  - Supporting services including primary production, nutrient cycling and soil formation;
  - Provisioning services comprising of the supply of food, fibre, fuel, timber and water; raw earth material; surface stability; habitat and genetic resources;
  - Regulating services such as water supply and quality, carbon sequestration, climate regulation, control of floods and erosion; and
  - Cultural services denote the aesthetic and cultural benefits derived from soil use.



# Elements emphasized in VGSSM



- SSM related R&D associated with the following characteristics:
  - Minimal rates of soil erosion by water and wind;
  - The soil structure is not degraded (e.g. soil compaction) and provides a stable physical context for movement of air, water, and heat, as well as root growth;
  - Sufficient surface cover (e.g. from growing plants, plant residues, etc.) is present to protect the soil;
  - The store of soil organic matter is stable or increasing and ideally close to the optimal level for the local environment;
  - Availability and flows of nutrients are appropriate to maintain or improve soil fertility and productivity, and to reduce their losses to the environment;
  - Soil salinization, sodification and alkalinization are minimal;



# Elements emphasized in VGSSM



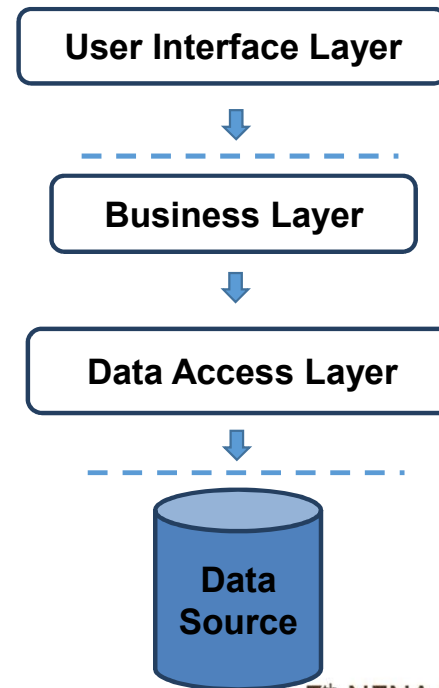
- SSM related R&D associated with the following characteristics:
  - Water (e.g. from precipitation and supplementary water sources such as irrigation) is efficiently infiltrated and stored to meet the requirements of plants and ensure the drainage of any excess;
  - Contaminants are below toxic levels, i.e. those which would cause harm to plants, animals, humans and the environment;
  - Soil biodiversity provides a full range of biological functions;
  - The soil management systems for producing food, feed, fuel, timber, and fibre rely on optimized and safe use of inputs; and
  - Soil sealing is minimized through responsible land use planning.



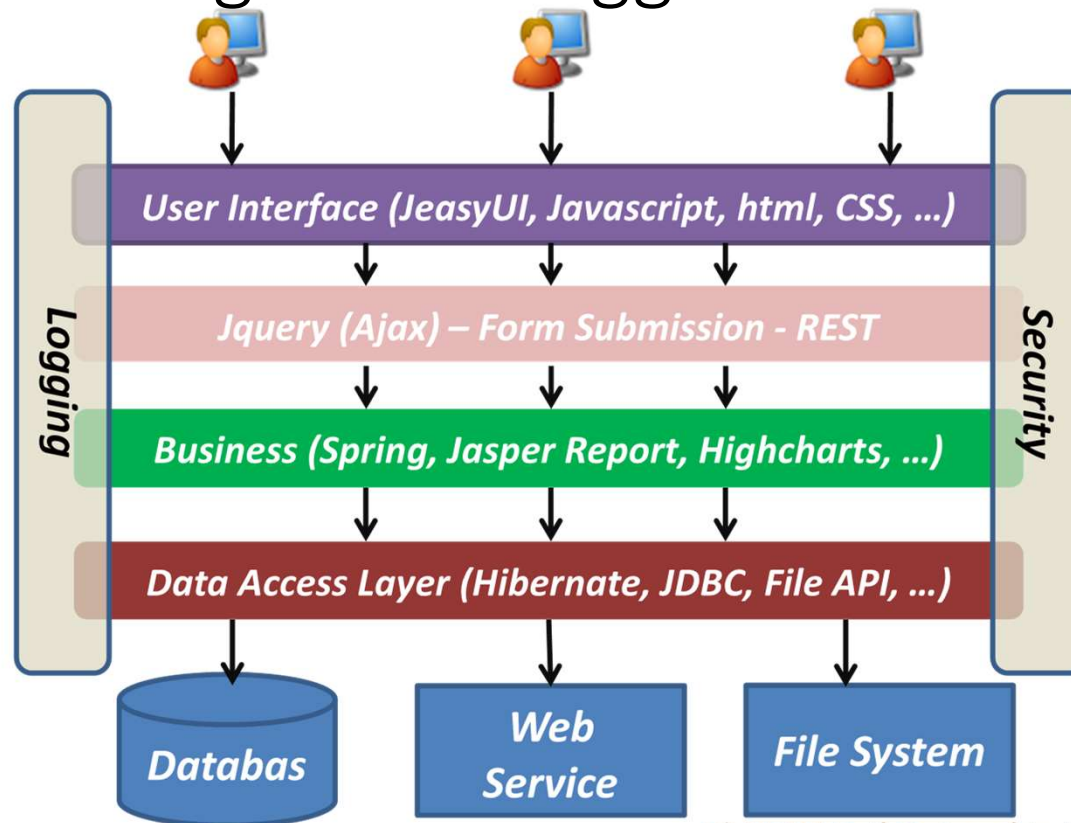
# Soil DB, DSS Software Multi-layered Architecture



Different and separate  
*UI, business logic* and  
*data Access layers*



# Software Production Process According to the Suggested Architecture

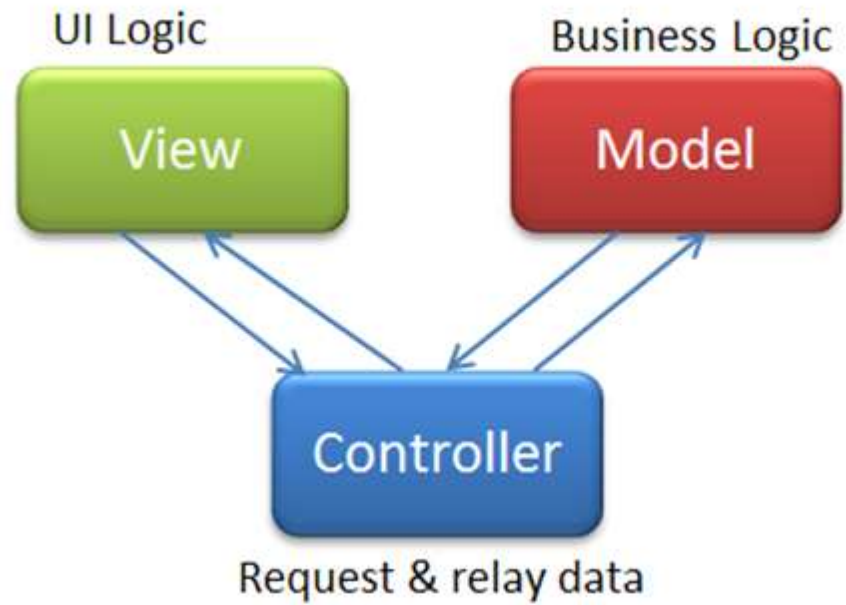


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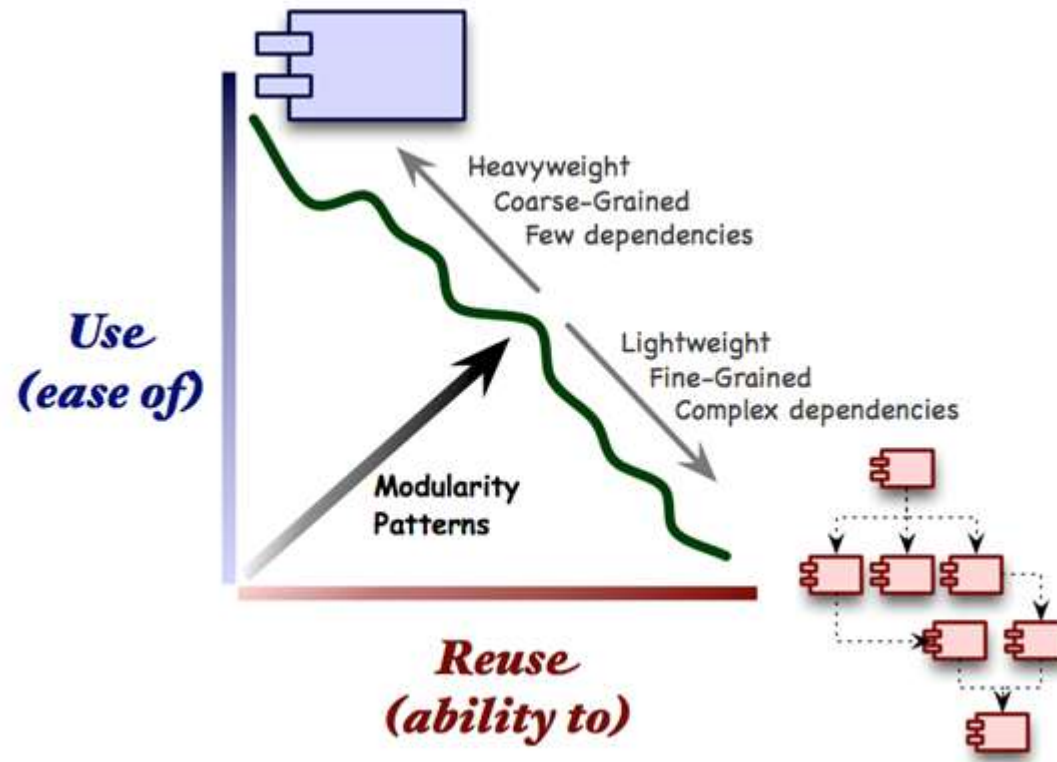




# MVC Standard



# Modularity of the Soil R&D&I&S DB



# What Has been Initiated in Asia

## Does it fit the needs?



Country	Formal name of Institution	Abbreviation of Institution	Location (city)	Host organization	Mission or purpose of institution (fewer than 100 words)
Website	Approximate number of professional staffs engaged in R&D for SSM	Key research/expertise on SSM	Major current R&D projects on SSM	Contact person(s) (name, position, e-mail)	



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*Thanks for your attention*

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