


TRAINING COURSE ON SITE-SPECIFIC SLM FOR THE SAVANNAH BELT OF NORTHERN NIGERIA
Amman, 4-9 June 2018


Soil and Water Conservation

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1. SOIL CONSERVATION
2. EVALUATION & SCALING



1. SOIL CONSERVATION (SC)
(Soil & Water Conservation – SWC)



why



Soil is a strategic resource to ensure food security


WHERE FOOD BEGINS

95%


of our food comes from soils

Source: FAO-GSP


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Soil



"LAND" = terrestrial bio-productive system that comprises **soil**, vegetation, other biota, and the ecological and hydrological processes that operate within the system (UNCCD)




Soil = earth's **living skin**

Pedosphere is the soil cover of the earth (is the earth's mantle of soil)

Very thin, not renewable!

Figures from Web resources

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Soils and land in the SDGs

(Target 2.4) By 2030 ensure **sustainable food production systems** and implement resilient agricultural practices that increase productivity and production, help maintain ecosystems, strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and, progressively **improve land and soil quality**.

(Target 15.3) by 2030, **combat desertification, and restore degraded land and soil**, including land affected by desertification, drought and floods, and strive to achieve a land-degradation neutral world

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what

Formerly (since 1930s): Soil Conservation (SC) = erosion control

"This attitude is still found in places; it leads to planning measures and projects in which erosion is thought of in terms of loss of soil material, and its control is treated in isolation from other aspects of agricultural improvement" (A. Young, 1989. AGROFORESTRY FOR SOIL CONSERVATION)







Images randomly taken from the web after googling "soil conservation"

It is **now** recognized that (A. Young, 1989)

- 1) the principal adverse effect of erosion is **lowering of fertility**, through removal of **organic matter** and nutrients in eroded sediment
- 2) there can be serious soil-degradation problems (various kinds of physical, chemical and biological degradation sometimes grouped as decline in soil fertility) in areas where erosion is not a problem, and that it is part of the task of soil conservation to address these

Soil conservation = maintenance of soil fertility


which requires:

- control of erosion (**pre-requisite**)
- maintenance of organic matter
- maintenance of soil physical properties
- maintenance of nutrients
- avoidance of toxicities.

}

Need synergistic action, integration

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Conservation Agriculture (CA) is an approach to *managing agro-ecosystems for improved and sustained productivity while preserving and enhancing the resource base*.


CA is characterized by three linked principles, namely:


- Continuous **minimum** mechanical soil **disturbance**.
- Permanent organic soil **cover**.
- **Diversification** of crop species grown in sequences and/or associations.

<http://www.fao.org/ag/ca>

A very specific agronomic method, part of soil conservation

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 Soil conservation is the **protection of soil from erosion and other types of deterioration**, so as to **maintain soil fertility and productivity**.

better: **soil conservation** \Leftrightarrow **sustainable soil management**

Sustainability ?

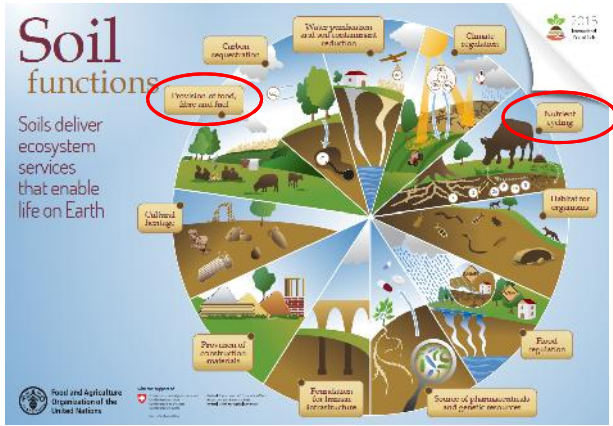
=> preserve/improve soil functions, ecosystem services provided by soil

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Soil functions

Soils deliver ecosystem services that enable life on Earth



Source: FAO-GSP

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SWC in socio-ecological context :

Land Degradation contexts => context-specific SWC options

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Issues to tackle

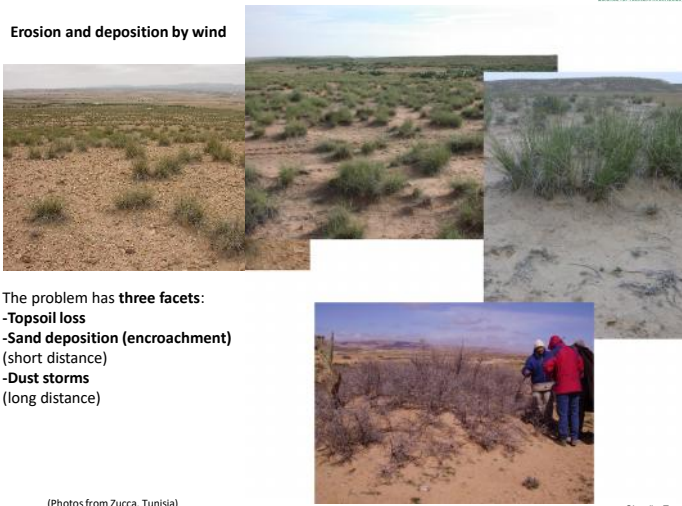
water erosion : varying processes, and drivers



(Photos by various sources)

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Erosion and deposition by wind



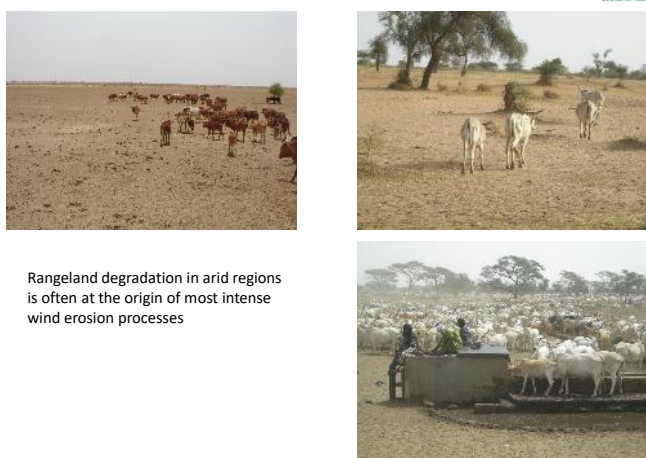
The problem has **three facets**:

- Topsoil loss
- Sand deposition (encroachment) (short distance)
- Dust storms (long distance)

(Photos from Zucca, Tunisia)

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Rangeland degradation



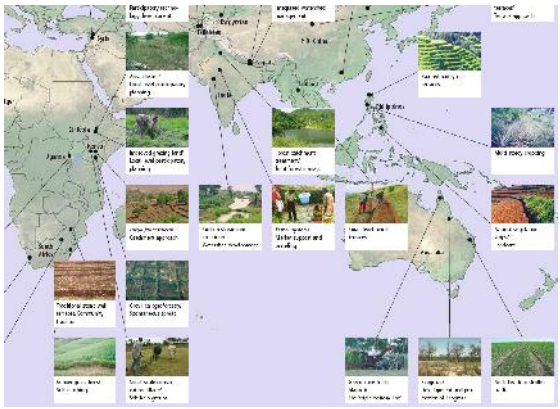
Rangeland degradation in arid regions is often at the origin of most intense wind erosion processes

(Photos by Zucca, Mauritania, Senegal)

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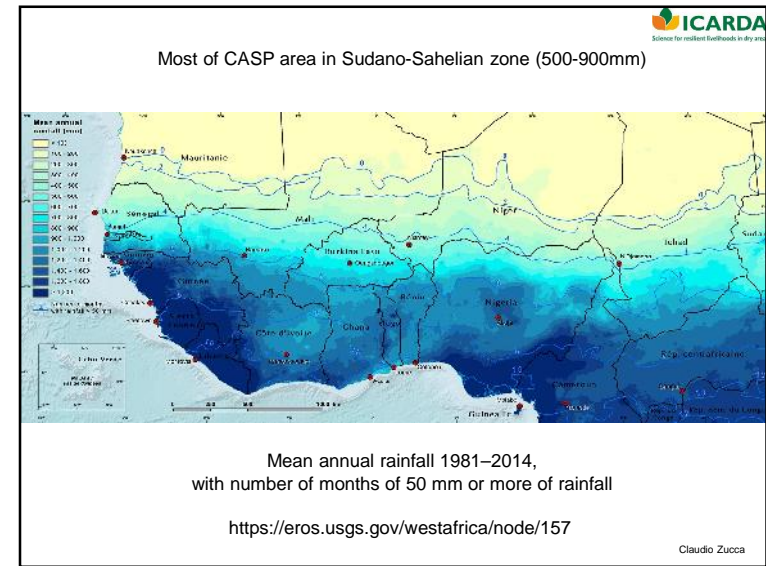
Options Plenty of approaches, methods, traditional and new !!!

Example: **WOCAT** (Global standardized presentation of Conservation technologies & approaches)



*Need to apply to **right one in the right place**.....CONTEXT-SPECIFIC !*

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WOCAT: Sustainable land Management (SLM) types

<ul style="list-style-type: none"> Natural and semi-natural forest management Forest plantation management Agroforestry Windbreak/ shelterbelt Area closure (stop use, support restoration) Rotational system (crop rotation, fallows, shifting cultivation) Pastoralism and grazing land management Integrated crop-livestock management Improved ground/ vegetation cover Minimal soil disturbance Integrated soil fertility management Cross-slope measure Integrated pest and disease management (incl. Organic agriculture) 	<ul style="list-style-type: none"> Improved plant varieties/ animal breeds Water harvesting Irrigation management (incl. Water supply, drainage) Water diversion and drainage Surface water management (spring, river, lakes, sea) Groundwater management Wetland protection/ management Waste management/ waste water management Energy efficiency Beekeeping, aquaculture, poultry, rabbit farming, silkworm farming, etc. Home gardens Ecosystem-based disaster risk reduction Post-harvest measures
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Nature of the measure

- Agronomic measures
- Vegetative measures
- Structural measures
- Management measures

WOCAT Definition of SLM:
« agronomic, vegetative, structural and/or management measures that prevent and control land degradation and enhance productivity in the field »

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SWC in LD policies :

SLM, rehabilitation; prevention, mitigation

Figure 1. Soil restoration strategies, either livelihood- or ecosystem-oriented.

Costantini et al. 2016; Zucca et al. 2013

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Improved farming practices

Crop rotation (e.g. cereal-legume)

Managing the cropping pattern and succession in the field
Generally oriented to crop yield and soil fertility

“Traditionally, farmers in Northern Nigeria have maintained soil fertility through **bush fallow**. Arable land was allowed to revert to fallow after 3-4 years of continuous cultivation, so that natural vegetation could regrow for 7-10 years. Mounting demographic pressure and other socio-economic pressures have forced farmers to shorten or skip the fallow period” (Yusuf&Yusuf, 2008)

Furthermore:

Residues removed
Collected for livestock (e.g., groundnut)
Grazed and burned (e.g., sorghum stubbles)

Yusuf A.A., Yusuf H.A., 2008. Evaluation of Strategies for Soil Fertility Improvement in Northern Nigeria and the Way Forward.

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Scientific literature demonstrates effectiveness of improved rotations in CASP area.

Example (Yusuf&Yusuf, 2008; 100 farmers in 6 villages)


Soybean/maize or soybean/sorghum in ratio 4:2. Crops are rotated in the following year providing two crops for the farmers in same year and residual N and other rotation benefits are utilized in the following year. In the second year crop residues are either incorporated in the field or fed to livestock and the manure is returned to the field.

Work needed on constraints and barrier to adoption


- No unproductive fallow
- Multiple crops in same year
- Livestock integration for better use of residues

.....

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Improved farming practices. Intercropping 

Managing the cropping pattern and succession Generally oriented to **crop yield and soil fertility**




As for rotation, scientific literature demonstrates the potential agronomic advantages of improved intercropping in Northern Nigeria.

Example:
Kamara et al. (2017) recommend intercrop soybean and maize with maize spaced at 50 cm and 65 cm to enhance land equivalent ratio and monetary advantage.



Kamara et al., 2017. Maize-soybean intercropping for sustainable intensification of cereal-legume cropping systems in northern Nigeria. *Experimental Agriculture*, 1-15.

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Improved farming practices. Intercropping 

Important effects on **runoff/erosion** !



<https://www.asianscientist.com/intercropping-erosion-com-chili/>

Earliness, density, and height of canopy cover provided by the complementary crop, especially if main crop offer low-late cover (e.g., maize)

Flat areas: Reduced **splash** effect on soil structure and soil **sealing/crusting**; increased **infiltration**, reduced ponding and runoff. Increased soil moisture (along with shadowing)

Gentle slope: Reduced runoff and **sheet erosion** (Contour ploughing recommended on slopes)

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Improved farming practices. Residue management 

Mulching




More oriented to: **runoff control, soil moisture conservation** during the cropping season

(But in CASP areas residues are rarely kept in the field)

Manuring



More oriented to: **soil fertility and health**

Universal practice of CASP farmers

But, is manure quantity and quality adequate?

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Improved farming practices. Residue management 


Improving quantity and quality of manures through better livestock integration

Often, farmers are not owner of most grazing livestock

Some communities think that manure left by nomadic herds is enough

Feed production

Composting



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Improved farming practices. Cover crops/productive fallows 

More explicitly oriented to **erosion** control, along with recovery of **fertility**

More typical in temperate climate, to cover soil during cold-rainy season, after the harvest
Avoid bare soil during rainy periods.




<https://www.kansasagnetwork.com/> <http://agriculturewire.com/>

Concept can be transferred and adapted to drylands to **reintegrate fallow**, in a **productive** form.
E.g., feed legumes

Produce more manure !


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Improved farming practices. Alley cropping 

Less oriented to yield production;
stress on **integration, diversification** (e.g., fruit).
Also: biologic hedges; **habitat** for pollinators; agroforestry


Options for crop-livestock integration in cereal-based rainfed systems


Atriplex species in Alley-cropping systems with cereals




Alley cropping Benefits:

- Provides fodder in times of scarcity.
- Provides rich and diverse diet for livestock.
- Reduces the need for chemical fertilizers and improves soil fertility.
- Reduces erosion in irrigated and rainfed areas.


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Improved farming practices. No tillage 

No-till (NT) technology



NT after cover crop



**Minimum soil disturbance
stubble retention
Direct seeding (affordable machinery)**

Benefits:
Savings in time, energy (fuel), machinery wear
Timely sowing
Higher yield potential

Enhanced soil structure and Moisture
less soil erosion

<http://agriculturewire.com/> Claudio Zucca

Local fabrication of zero-tillage seeders: Part of the solution

Imported seeders
Price: US\$ 30,000 to \$60,000



Locally manufactured seeders (Iraq, Syria, Morocco)
Price: US\$ 1500 to 6000



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Erosion control measures. Ridging



Ridging and contour ridging

Strongly oriented to **runoff** control, **soil moisture** conservation during the cropping season

In CASP areas, often practices with cereals (sorghum, millet) but in several cases non well done (e.g., along slope), or not enough to control runoff



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Erosion control measures



Runoff can be controlled by structural measures

- slowing down runoff and increasing infiltration as much as possible (trying to keep water in the field)

And/or

- capturing excess runoff and safely diverting it from the field

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Erosion control measures. Contour bunds



Stone bunds, cereal cropping (Ethiopia)

Among the most widespread large-scale soil conservation and rehabilitation measure implemented by the Ethiopian Government implemented to mitigate soil loss



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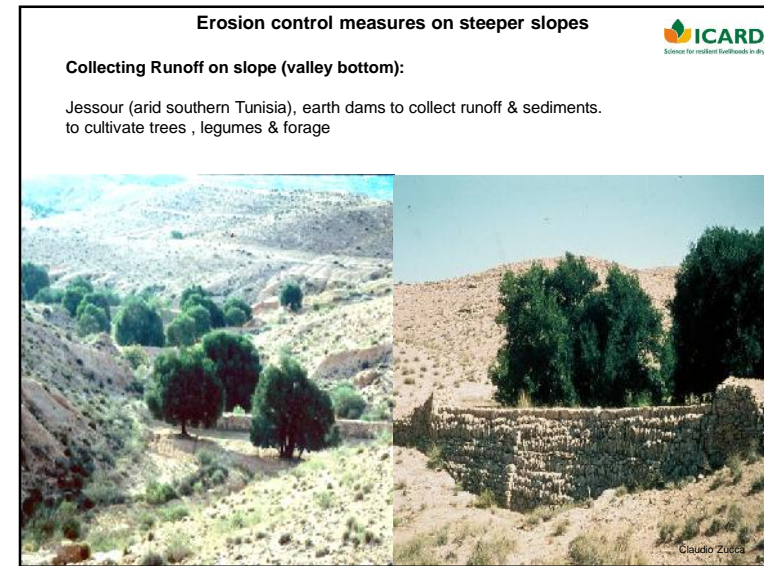
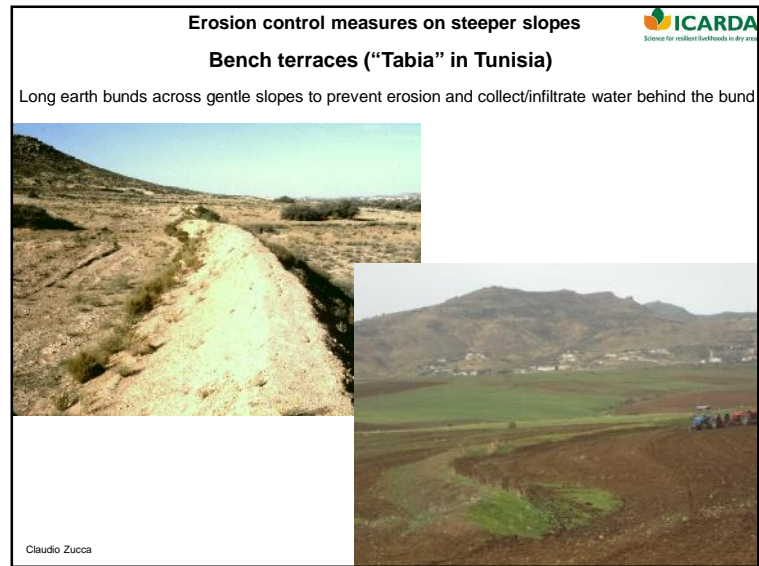
Erosion control measures. Contour bunds

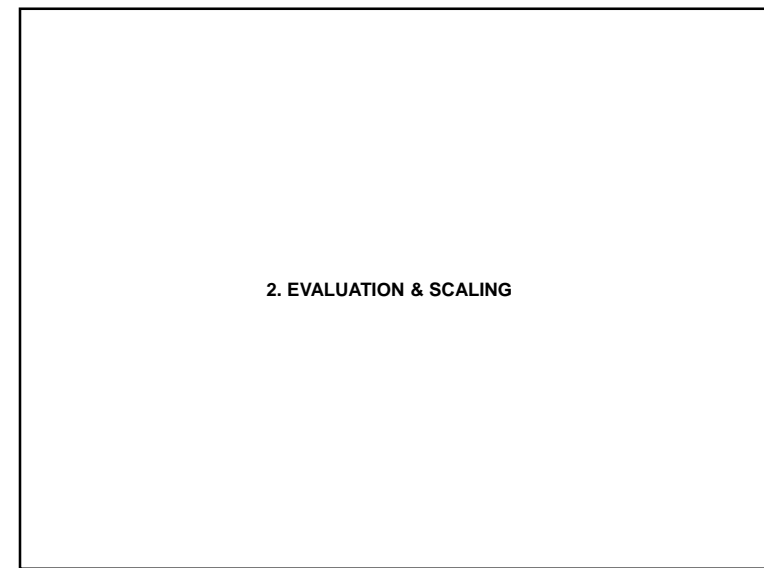
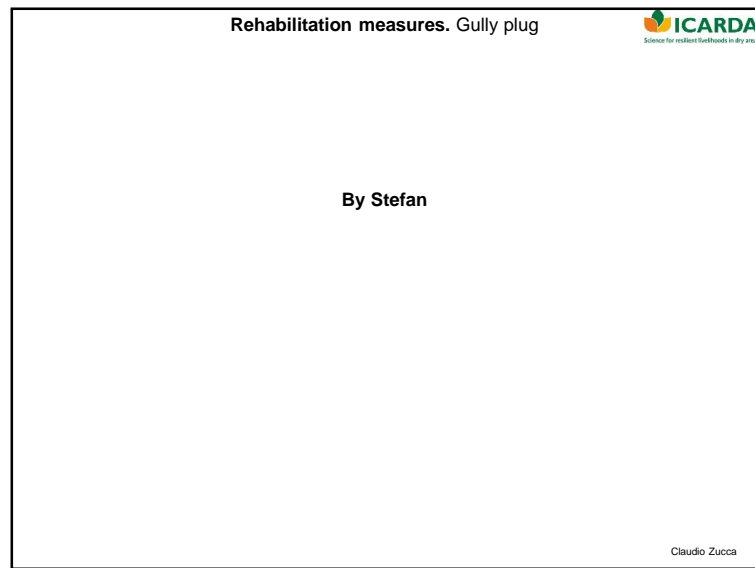
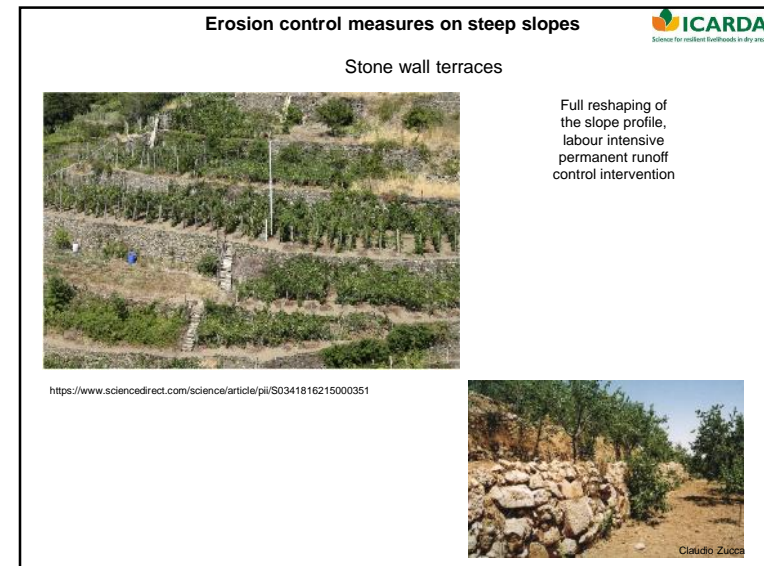
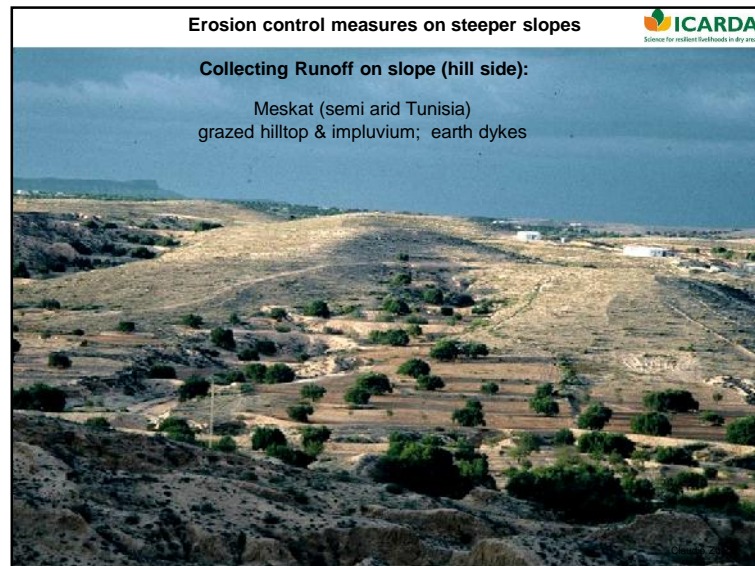


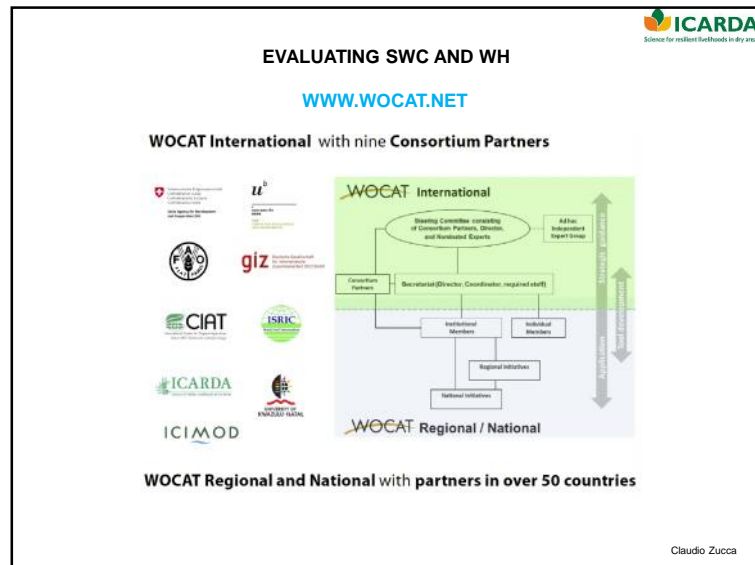
Earth bunds on steep pasturelands (Sardinia, Italy)




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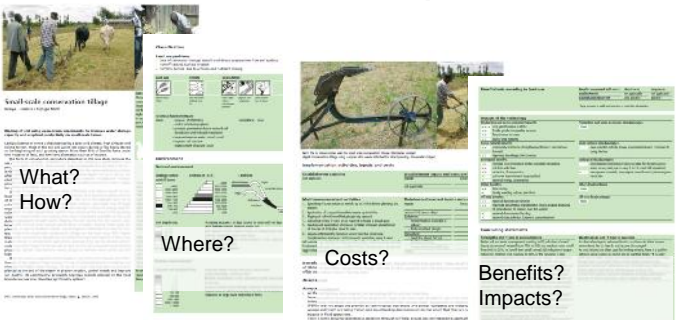




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Key for Knowledge Management and Decision Support in SLN

Standardized tools & Harmonized products

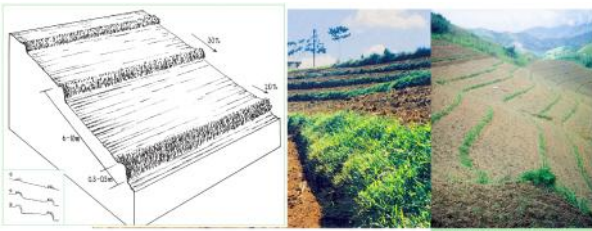


SLM Technology

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Technical description




Natural vegetative strips
Philippines

Within individual cropland plots, strips of land are contour and left unploughed in order to form per barriers of naturally established grasses and herbs.


Natural vegetative strips (NVS) are narrow live barriers containing grasses and herbs. Contour lines are laid out with an "eye's back method" (a row is used to walk across the slope contour and this is confirmed when its back is seen to be then pegged to serve as an initial guide to ploughing. The are left unploughed to allow vegetation to establish, the

Degradation



water erosion: loss of topsoil, gully

SWC measures

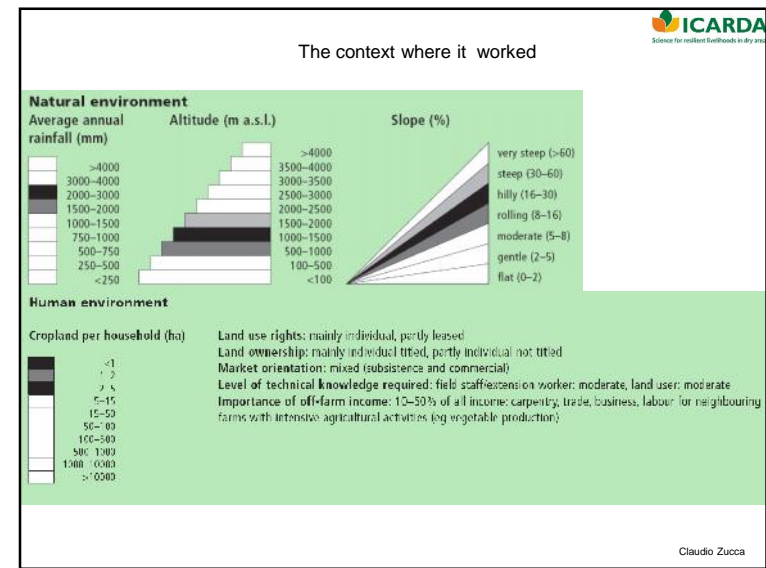


chemical: fertility decline

vegetative: narrow grass barriers

agronomic: contour plough, mulching (supp.)

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S & W

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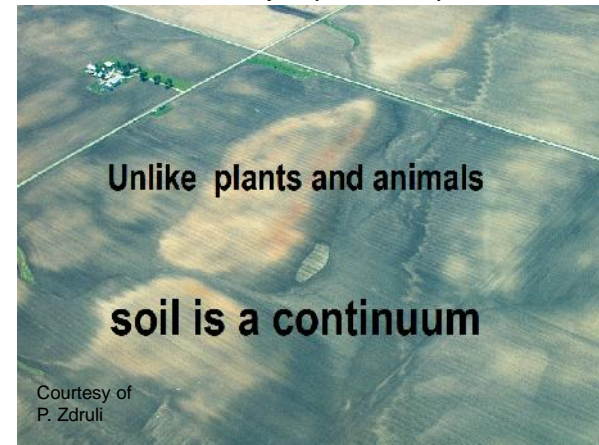
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TAKING SWC AND WH TO SCALE

Where

Sustainability : soil management part of land management

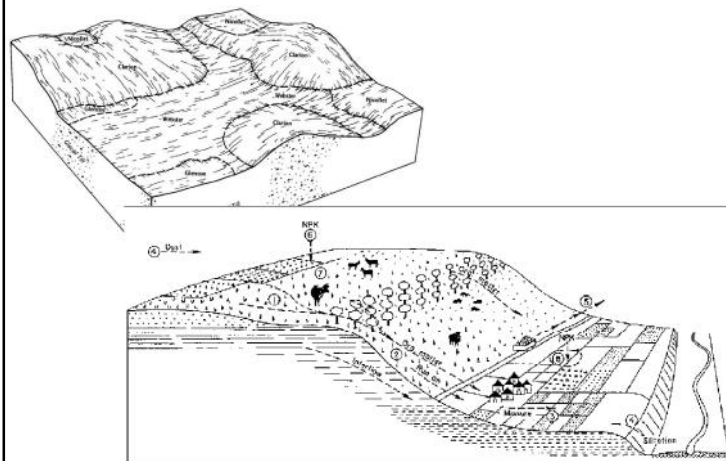
Variability in space, landscape!



Courtesy of
P. Zdruli

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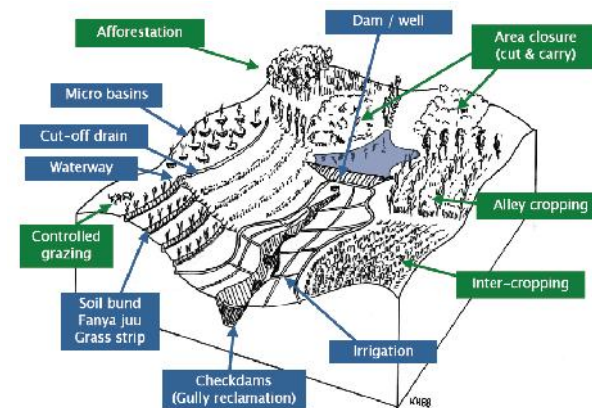
Soil spatial variability has rules, patterns in the landscape



Drawings from on-line resources

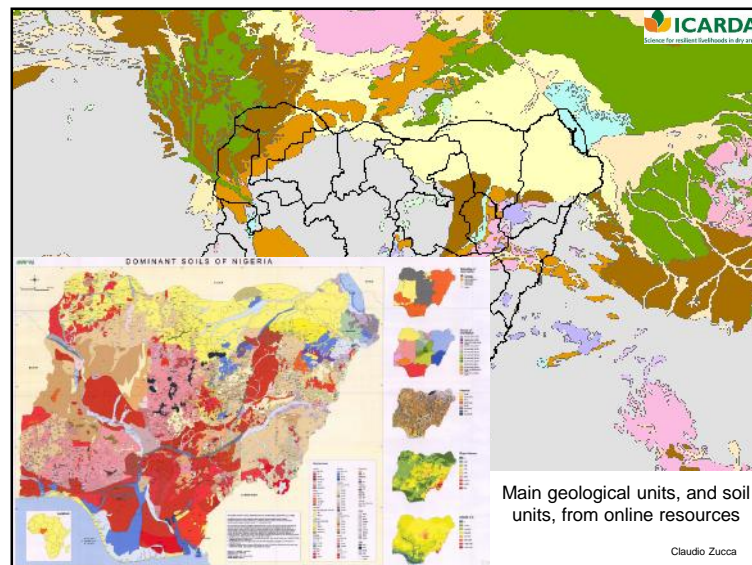
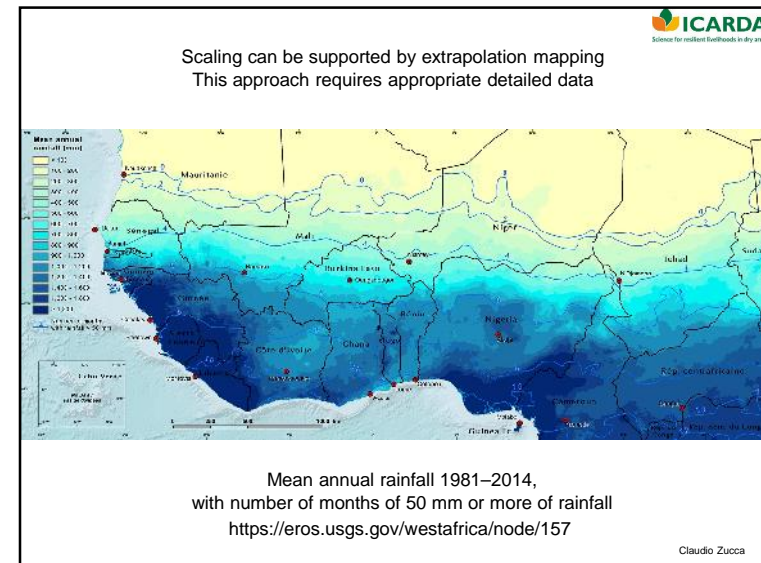
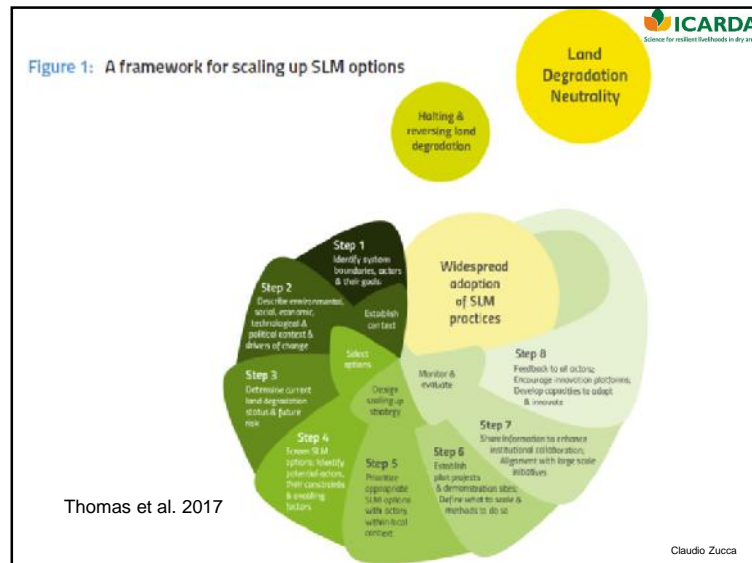
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BEST spatial arrangement of the different measures/ technologies and their impact



Graph: K. Harweg

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Thanks for your attention...

