Uso di dati e modelli in diversi contesti: dal monitoraggio agrometeorologico alle proiezioni di lungo termine per l'adattamento ai cambiamenti climatici in agricoltura. Casi studio da programmi FAO.

Maria Raffaella Vuolo, Ana Heureux, Mariko Fujisawa, Mauro Evangelisti, Hideki Kanamaru

FAO’s climate strategy on climate change and Climate Smart Agriculture: recommendations

- **Include climate and climate change considerations in projects, programmes, policies for promoting a sustainable agriculture**
- **Promote the concept of “Climate Smart Agriculture”**
- **Improve the understanding of climate change impacts on agriculture, for informed adaptation decisions**
- **Strengthen meteorological and agrometeorological networks for higher quality monitoring and data**

FARM-LEVEL ADVICE: agrometeorology and disease early warning systems in Macedonia

TCP project “Reducing the vulnerability of Agriculture to Climate Change”

Meteorological vs. *agro*meteorological stations

AWS Measured parameters

- Tair (Tmax & Tmin)
- TH (Mx & Mn)
- Wind speed (10m height)
- Wind direction
- Global radiation
- Precipitation
- Atmospheric pressure
- Soil temperature (0, 5, 10, 20 cm)

Calculated:

Tdew

AAWS Measured parameters

- Tair (Tmax & Tmin)
- TH (Mx & Mn)
- Wind speed (2m)
- Wind direction
- Global radiation
- Precipitation
- Atmospheric pressure
- Soil temperature (0, 5, 10, 20 cm)
- Soil moisture (30, 60 cm)
- Leaf wetness

Calculated:

Tdew
Sum of degree days (SDD)
Chilling hours
Potential evapotranspiration

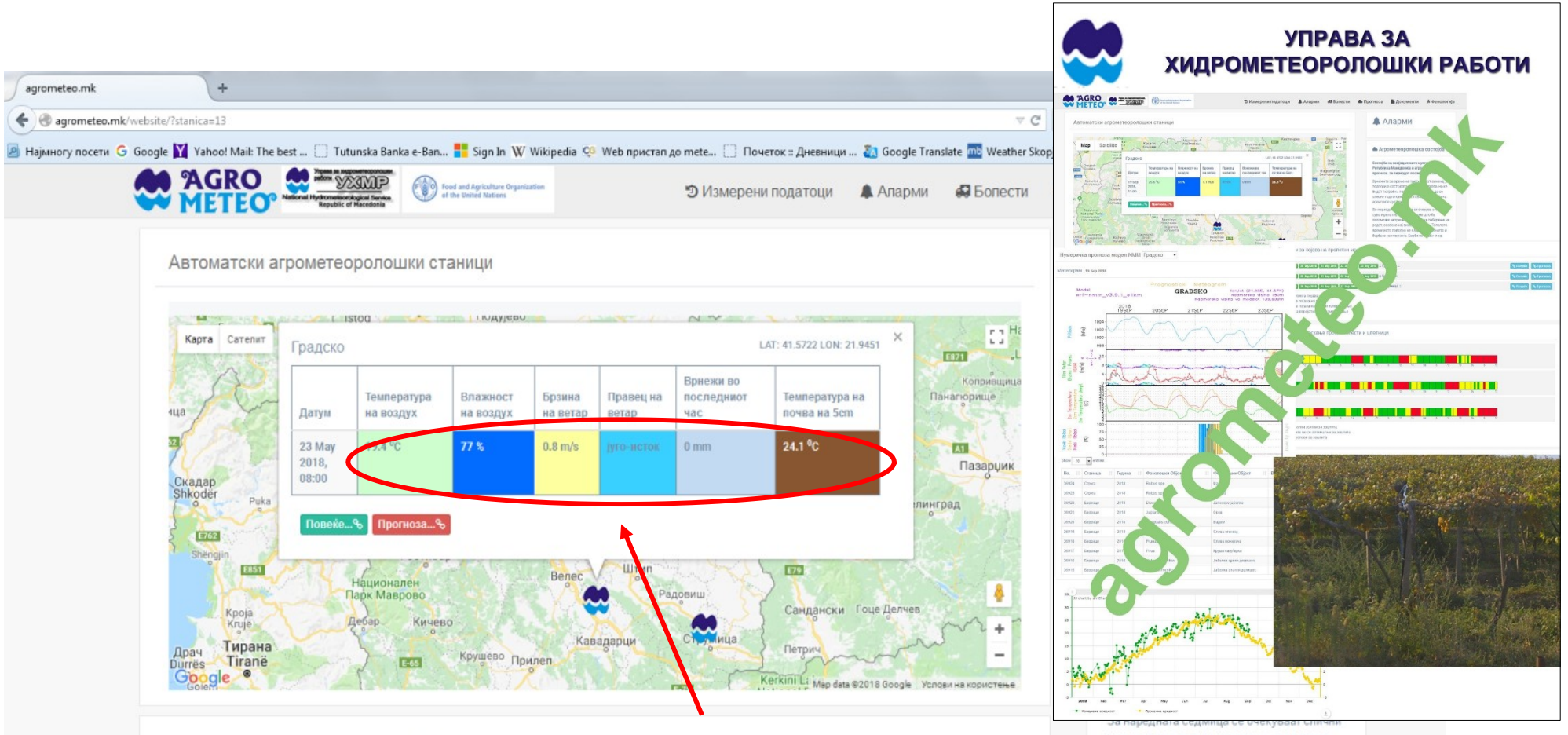
Increasing agrometeorological network

Three agriculturally important pilot sites were chosen for the installation of the automatic agrometeorological weather stations (AAWS):

- **Grandson** (vine region in the central part of the country)
- **Kocani** (rice plants in the east)
- **Strumica** (organic production of vegetables in the south east)

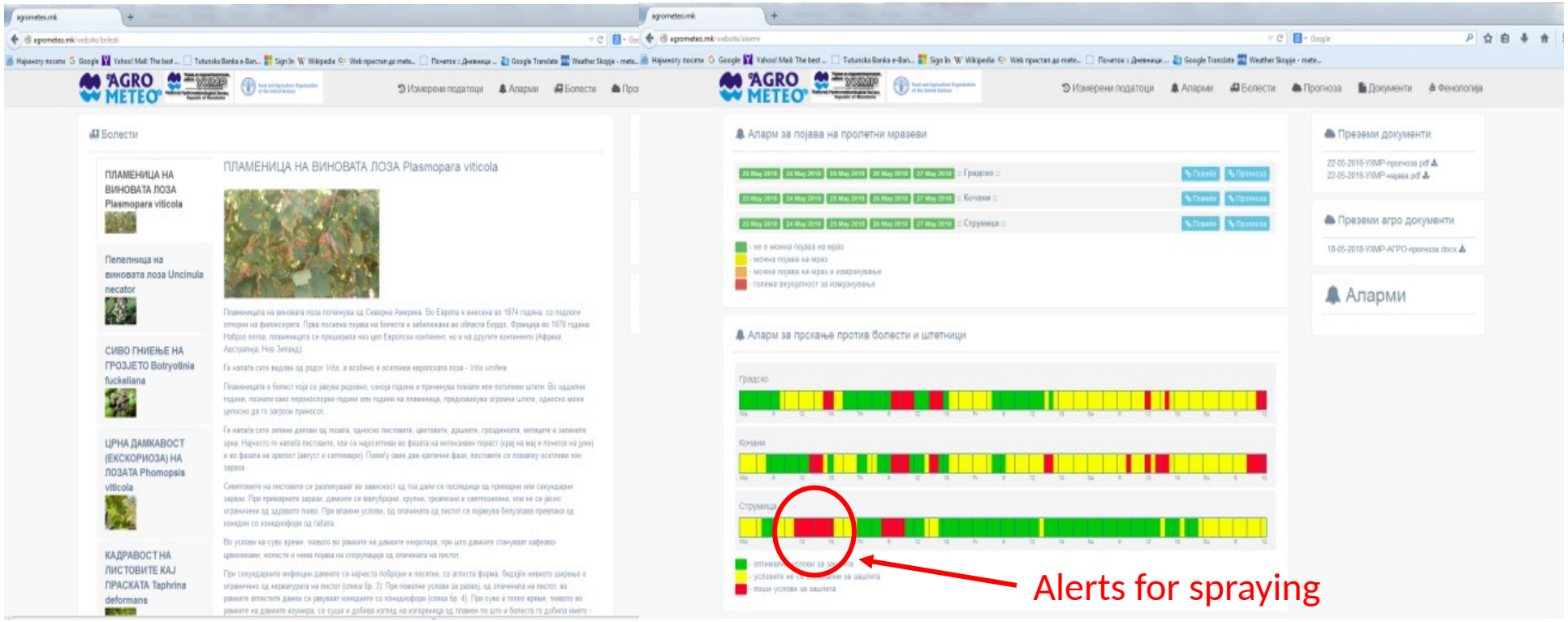
All sites represent important agricultural regions that require on farm monitoring of agrometeorological variables and calibration of crop and other agro-relevant models.

Development of knowledge sharing portal



Temperature, precipitation, wind speed, soil moisture and soil temperature

Monitoring of plant diseases in collaboration with national research institutions



> Measurements or estimations of leaf wetness can be used by plant pathologists to devise weather timed spray schemes, reduce the number of sprays required, lower costs and benefit the environment.

> Potential for forecast warnings of potential upcoming disease outbreaks

MOSAICC: Modelling system for Agricultural Impacts of Climate Change

Water balance model (Wabal, based on **FAO irrigation paper 56**)

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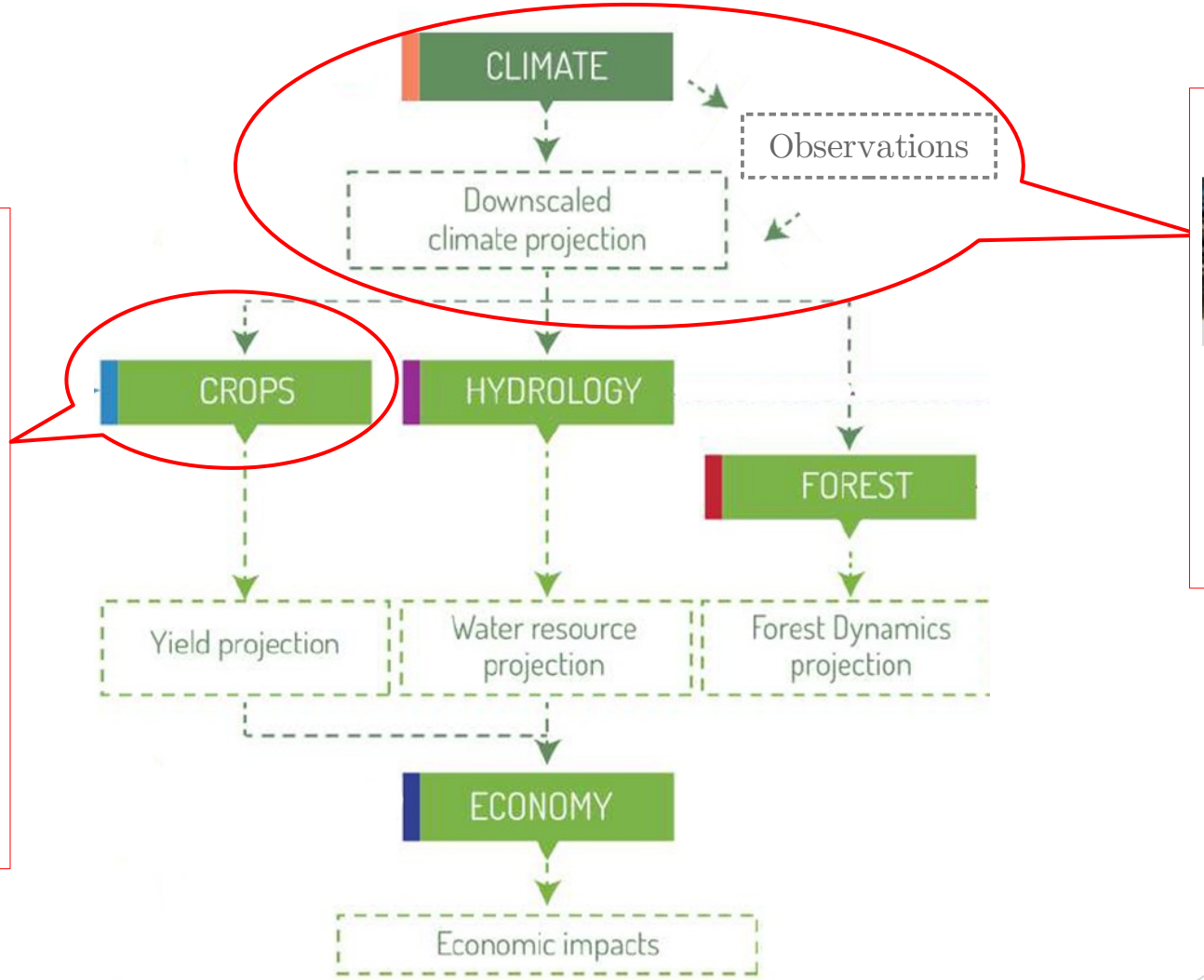
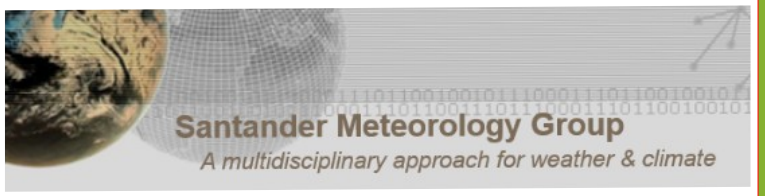
Statistical regression of historical yields with water balance and climate



Statistical Downscaling Portal



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AURELHY interpolation (Bénichou and Le Breton, 1986)

http://www.fao.org/in-action/mosaicc/en/

MOSAICC: capacity development and country-driven approach

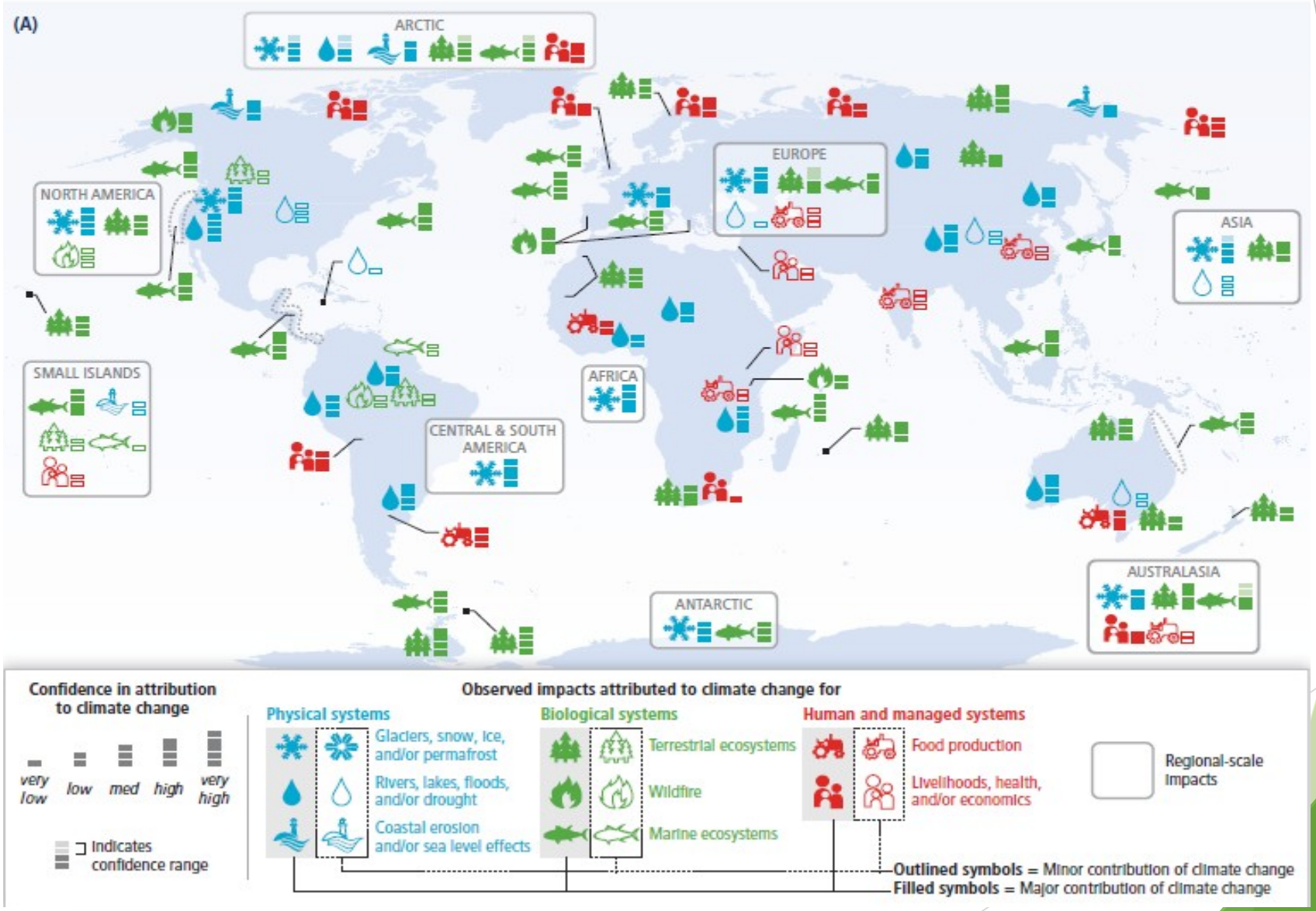
- **By** national scientists
- **With** country's own data
- **For** country's information needs

FAO's Strategy on capacity developement: ***transformation of FAO's role from that of a provider of technical assistance to that of a facilitator of change over extended time horizons***. This new approach builds on local resources, including people, skills, technologies and organizations, and it focuses on strengthening the sustainability of CD interventions by encouraging ***national ownership in development processes***.

- Build the collaborative framework among experts and institutions
- Study design considering country's objectives, priorities, vulnerabilities
- Learn from other countries' "MOSAICC experiences"
- Learn the use of the MOSAICC platform
- Share and exchange data, knowledge, skills, etc. among experts of different fields
- Produce preliminary results and discuss them in relationship with country's priorities
- Build the basis for long-term collaborations, exchanges, projects etc.

Climate change is global, but several *impacts* are *local*

- AR5 WG2, observed climate change impacts over the world

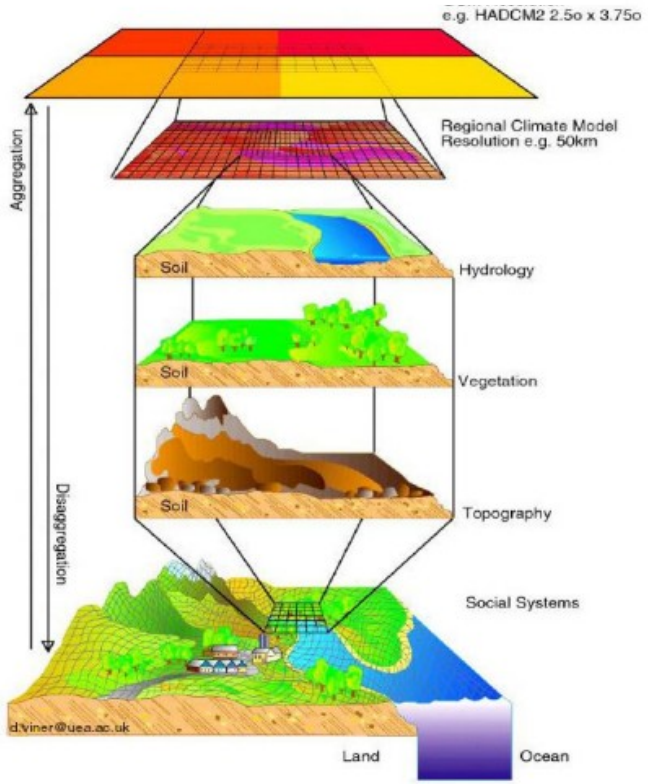


Some climate change impacts *on crops* (from IPCC AR5)

- *Negative impacts of climate change on crop yields: more common than positive impacts (high confidence)*
- *Projected impacts vary across crops and regions and adaptation scenarios, with about 10% of projections for the period 2030–2049 showing yield gains of more than 10%, and about 10% of projections showing yield losses of more than 25%, compared to the late 20th century.*
- *The smaller number of studies showing positive impacts relate mainly to high-latitude regions, though it is not yet clear whether the balance of impacts has been negative or positive in these regions (high confidence)*
- *For wheat, rice, and maize in tropical and temperate regions, climate change without adaptation is projected to negatively impact production for local temperature increases of 2°C or more above late-20th-century levels, although individual locations may benefit (medium confidence).*

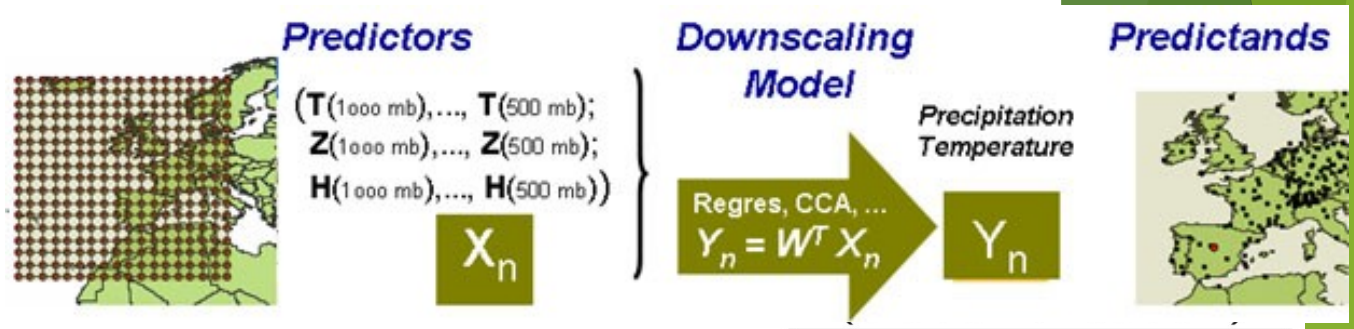
CLIMATE DOWNSCALING
from global to local…

Dynamical

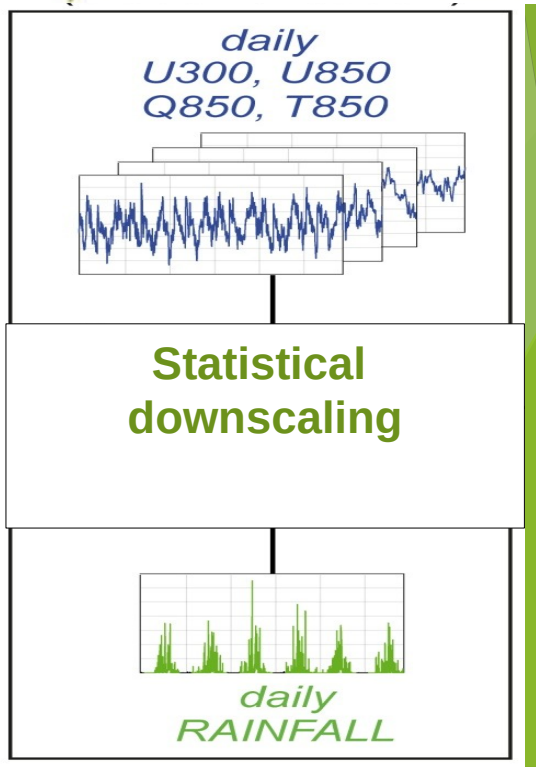


Many of the processes that control local climate, e.g., topography, vegetation, and hydrology, are not included in coarse-resolution GCMs. The development of statistical relationships between the local and large scales may include some of these processes implicitly.
Source: Viner, 2012

Statistical



Statistical downscaling links local observed climate **(predictand Y)** to gobal simulations given by the GCMs **(predictors X)** through some **function** and/or **parameters**



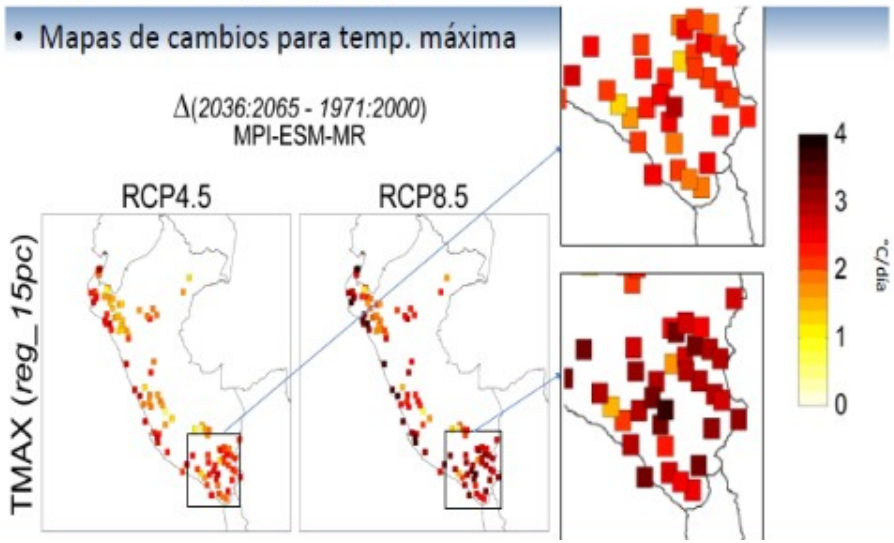
MOSAICC-climate SD (Peru)
Source: SENAMHI

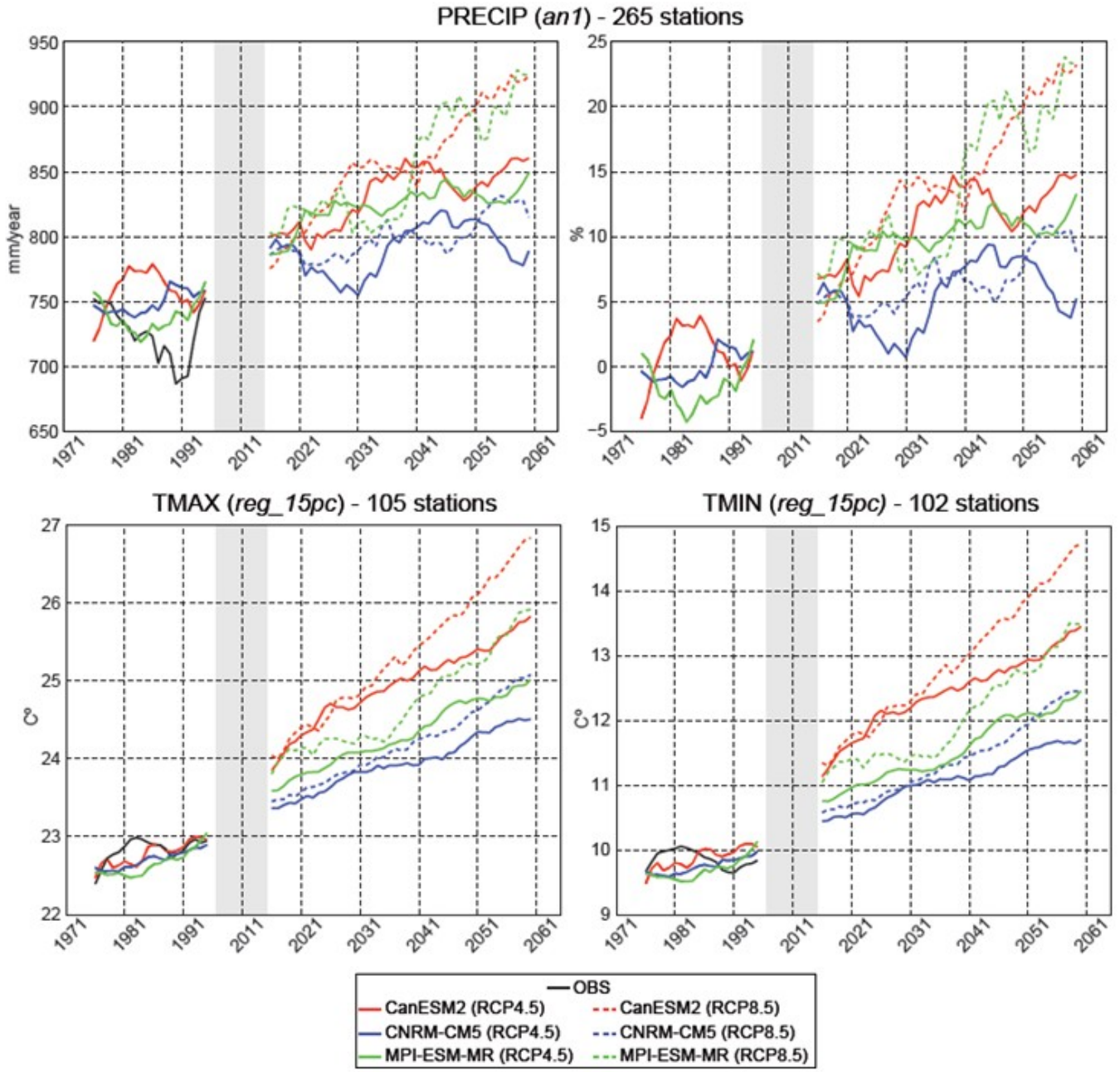
Predictors	Levels
2T, SLP , Z, T, Q, U, V	Surface, 1000, 850, 700, 500, 250 (hPa)

Nombre del ESM	Resolución
CanESM2	2.8◦ × 2.8◦
CNRM-CM5	1.4◦ × 1.4◦
GFDL-ESM2M	2.5◦ × 2◦
IPSL-CM5A-MR	1.5◦ × 1.27◦
MIROC-ESM	2.8◦ × 2.8◦
MPI -ESM- MR	1.8◦ × 1.8◦

Metodo	Descripcion
an1	Vecinos más cercanos
an5mean	Media de los cinco vecinos más cercanos
an15rnd	Uno de cada 15 vecinos (selección aleatoria)
reg 15pc	REG con 15 PCs
reg 4nn	REG con anomalías estandarizadas para las 4 grillas más cercanas
reg 15pc 4nn	REG con 15 PCs + con anomalías estandarizadas para las 4 grillas más cercanas

MOSAICC-climate SD results (Peru) AMICAF project Source: SENAMHI





MOSAICC crop component: study design in Uruguay (NAP project)

1) Criterios:

- Contribución a las exportaciones.
- Generación de puestos de empleo.
- Superficie que ocupa.
- Contribución al PBI agropecuario.
- Seguridad alimentaria.
- Ocupación de las pequeñas explotaciones (familiares).

2) Fuentes de información

- DIEA
- FUCREA
- INIA-INASE
- Molinos, malterías, empresas privadas
- Ensayos de INIA y FAGRO
- Económica: Cámara mercantil, CUSA

Fuentes de datos de fenología:

INIA-INASE

Datos de ensayos INIA y FAGRO

Publicaciones en Agrociencias; Tesis de grado

Empresas privadas (ERRO)

3) Escala espacial

Puntos (estaciones meteorológicas INIA/INUMET)
Estaciones meteorológicas
Zonas climáticas
Departamentos
País

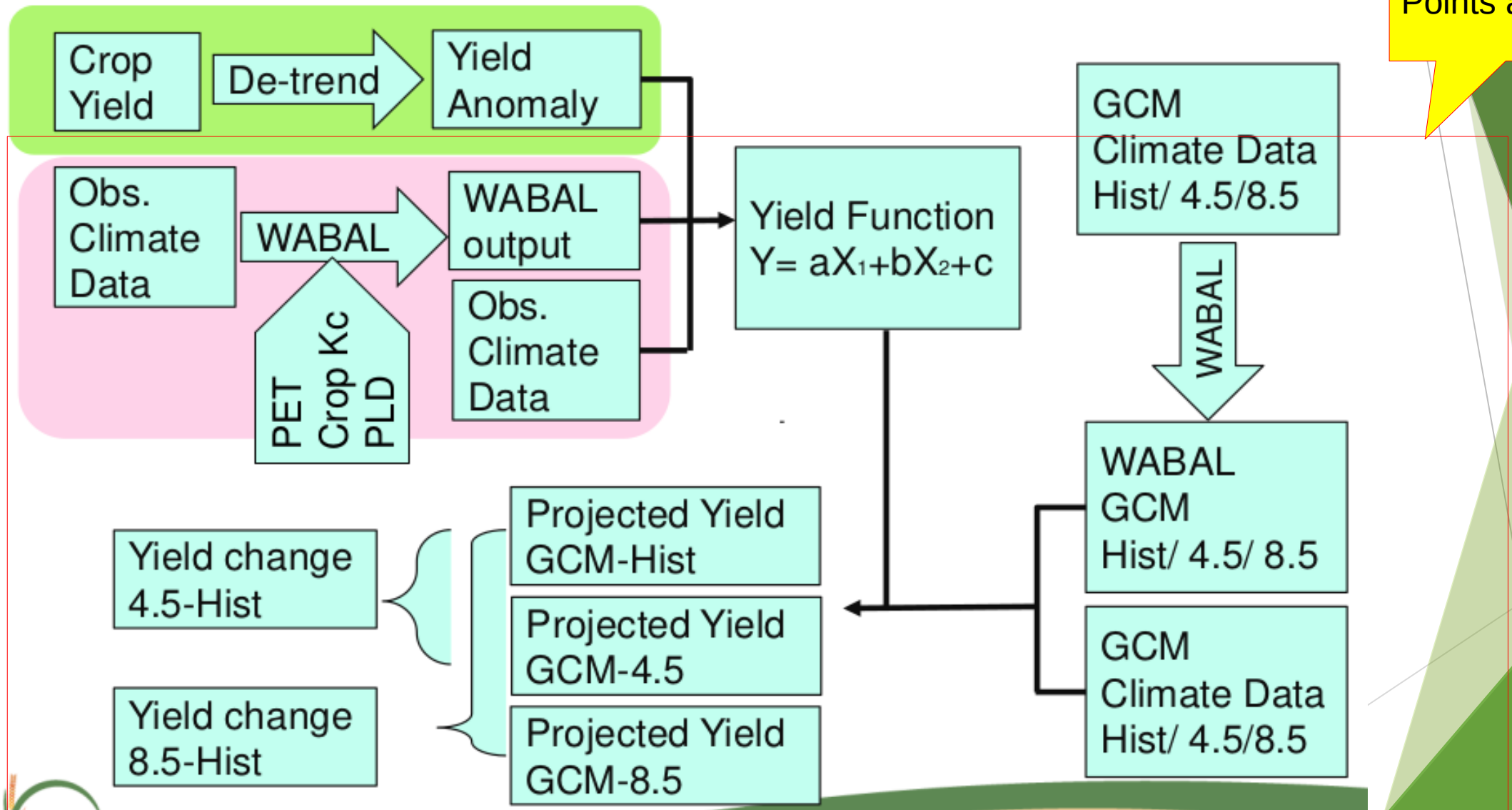
Need for interpolation

4) Cultivos

Soja
Trigo
Cebada
Maíz
Papa
Cebolla
Caña de azúcar

Yield Simulation (Summary)

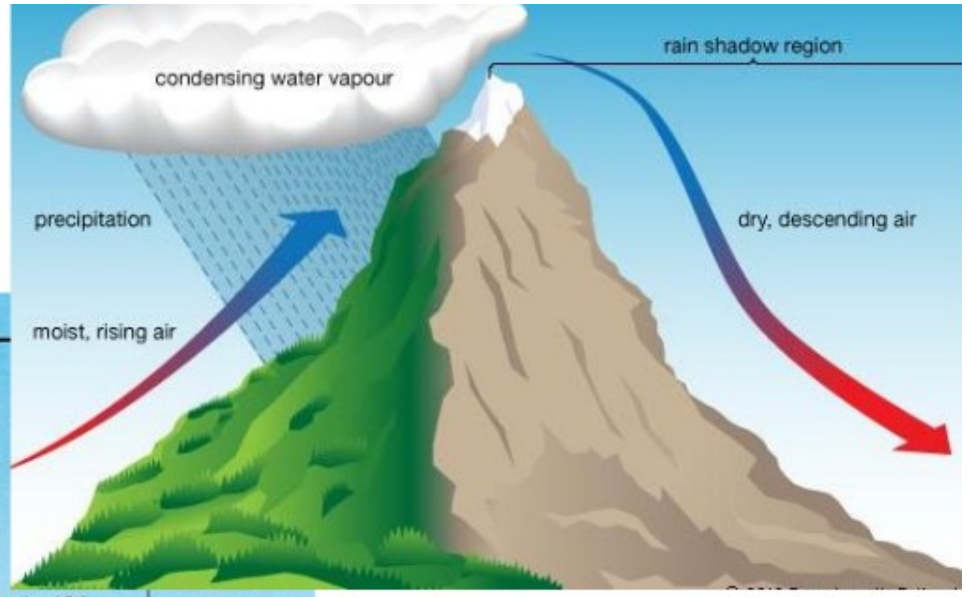
Points and GRID

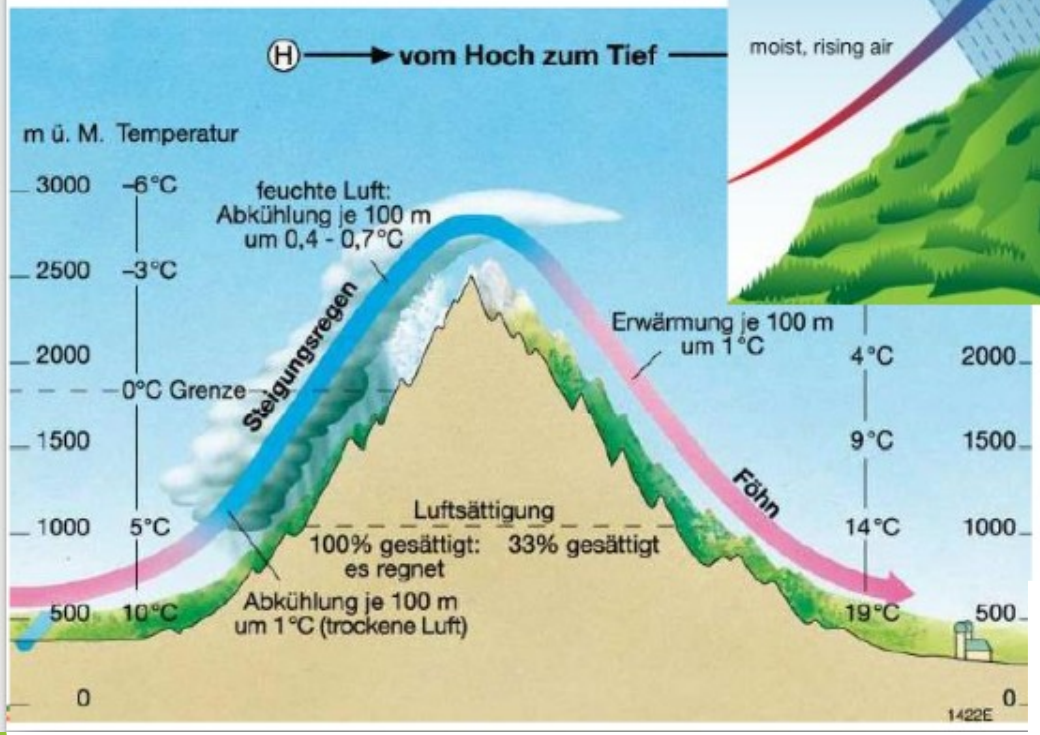


MOSAICC

AURELHY interpolation scheme

Influence of orography





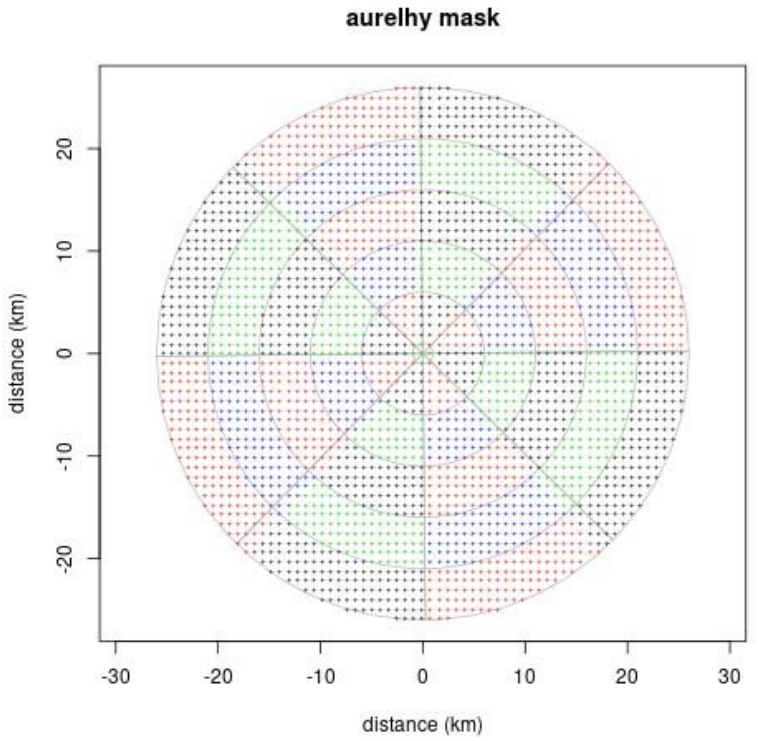
Influence of other phenomena
- land-sea effects
-E/W, N/S gradients

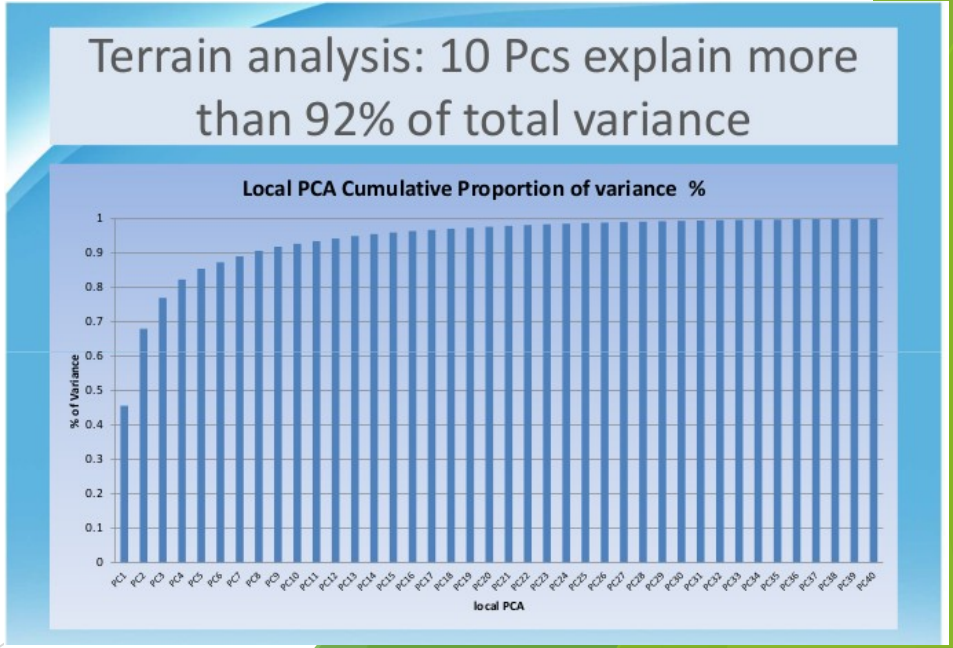
Model (Bénichou & Le Breton, 1987)

$$P(Si) = P(xi, yi, Ri) = f(Ri) + \varepsilon(xi, yi)$$

AURELHY step-by-step

- Terrain analysis: each point identified by a “mask” of n points (121 in the original version)
- PCA of local topography variables
-
- Regression of climate variable against PC and other relevant variables
- Prediction of gridded climate variable
- Spatial interpolation of residuals by Kriging
- Adding surface of interpolated residuals to surface predicted by regression

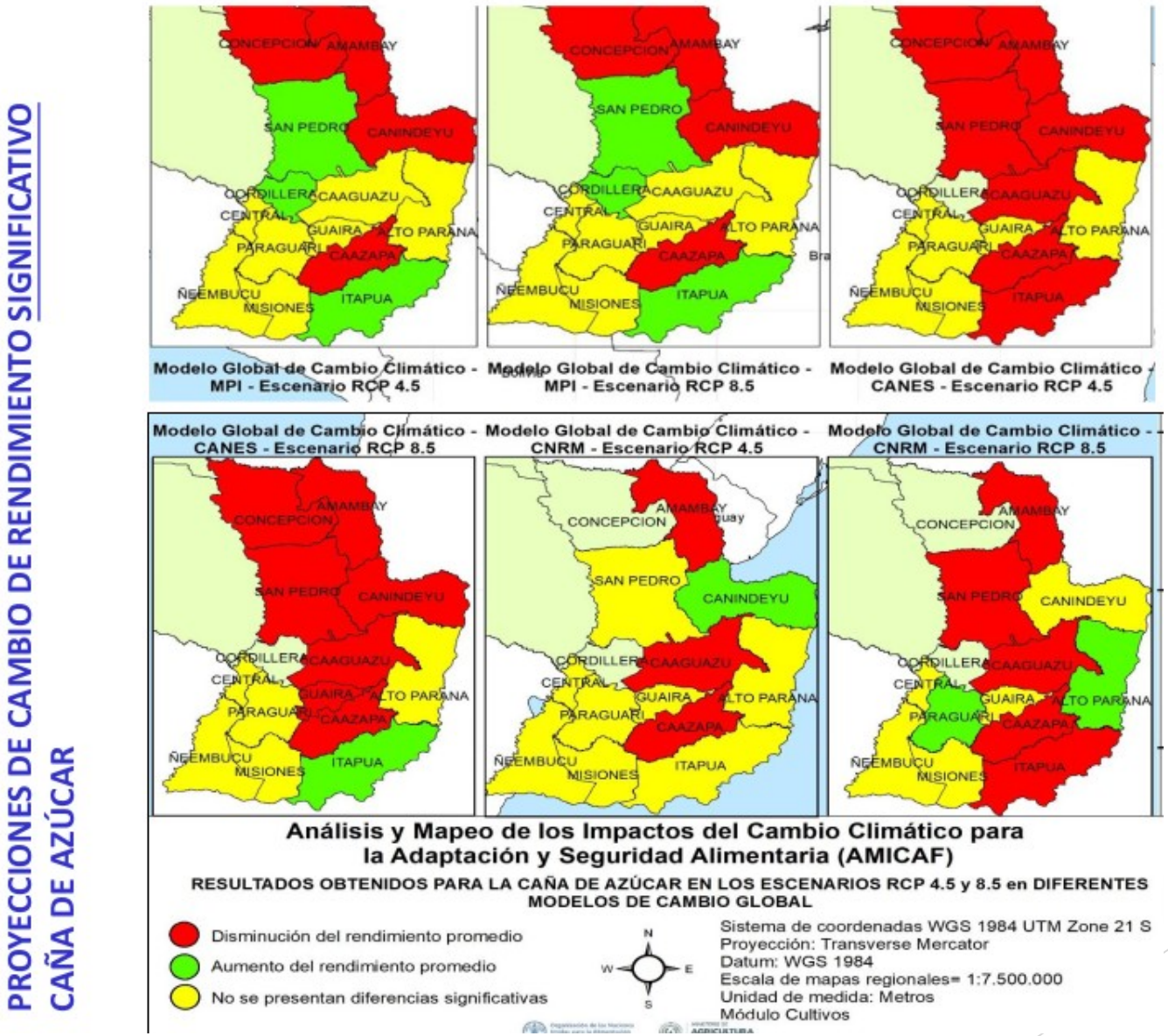




AURELHY issues in non-ideal conditions

- Regression against landscape variables: multicollinearity of predictors (reduced by stepwise method).
- Interpolation of highly temporally variable fields (daily, dekadal): more problematic for the “regression” part. Longterm averages: better regression, worse kriging of residuals.
- Low density of stations in several applications (average station distance in Morocco, Uruguay : 100 Km. In the original method: 15 Km).

MOSAICC-crop analysis in Paraguay (AMICAF project): some results



MOSAICC-crop analysis in Peru (AMICAF project): some results

Cultivo de papa

Cambio Rendimiento (Kg/ha)

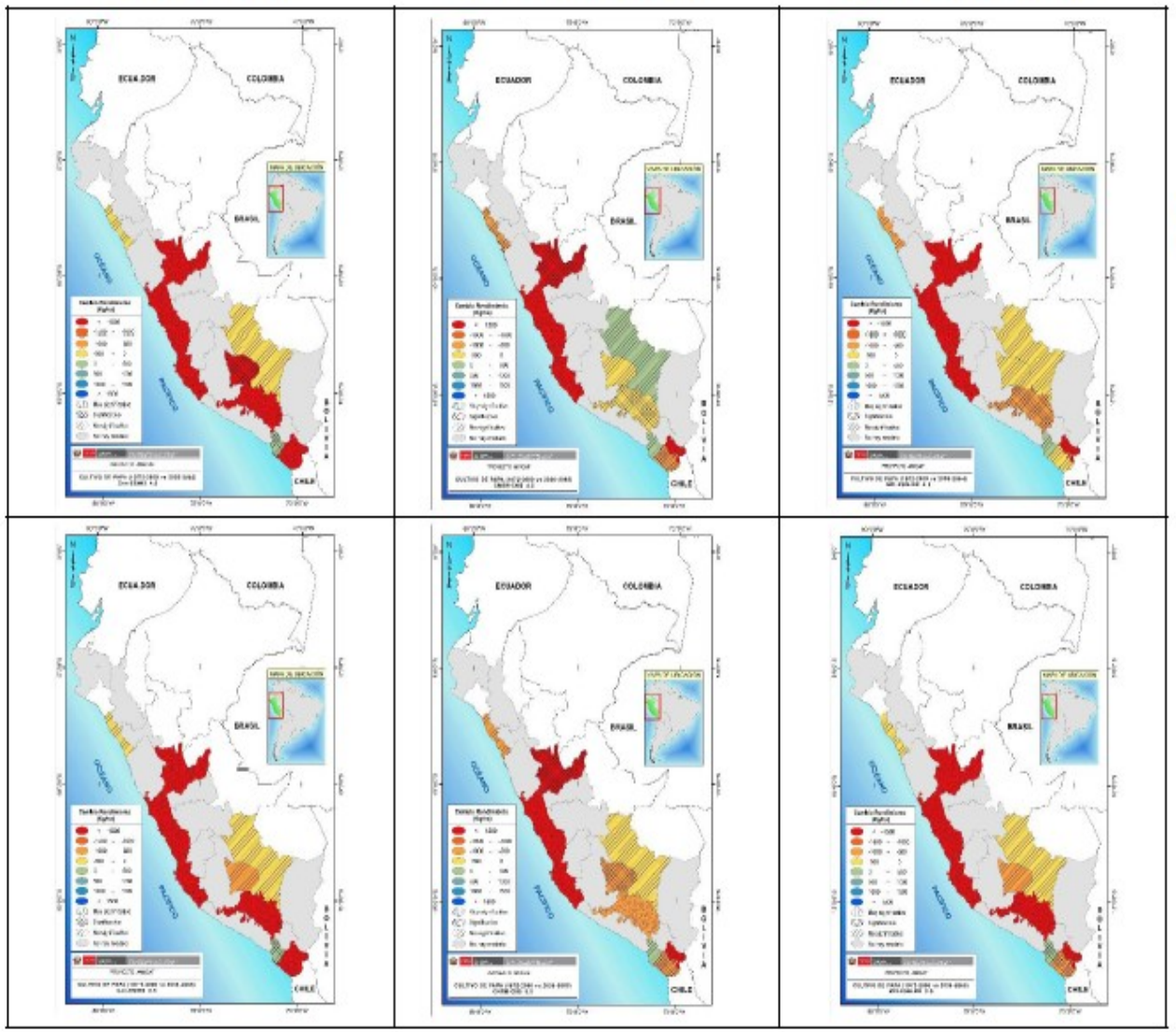
<	-1500
-1500	-1000
-1000	-500
-500	0
0	500
500	1000
1000	1500
>	1500

Muy significativo

Significativo

No significativo

No hay modelo



More information on:

http://www.fao.org/in-action/mosaicc/en/

- **Description of the system and the approach**
- **Description or references to the models/components**
- **Technical reports from the countries**
- **Non-technical documents from the countries (e.g. recommendationd for policymakers)**

Demonstrations on request

Grazie per l'attenzione!