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Application of the Climate Vulnerability Reduction Credit (VRC™) for Flood (and Drought) Vulnerable Communities

1. *Challenges and proposed solution: VRCs*
2. *Vulnerability Reduction Project Manager (VRPM) - Flood Defence + Case Study*
3. *Consideration of VRC metric's application for water and next steps*

Karl Schultz

INTERNATIONAL CONFERENCE ON ADAPTATION METRICS FOR WATER & AGRICULTURE
October 6th and 7th 2017

Many Challenges for Climate Adaptation

- Inadequate *funds*
- No clear *role for private sector* to invest in scalable solutions
- *Comparability* of actions: are funds going for maximum climate vulnerability reduction?
- Identifying *good adaptation projects*
- *Robust baselines, monitoring and verification*
- *Sustainability* of vulnerability reduction measures

Our Proposed Solution: Vulnerability Reduction Credit (VRC™)

- Investment Prioritization and Fundraising:
  - Mobilize public and private
- Efficiency:
  - Identify/develop/credit most cost effective adaptation measures
- Rigor and Creativity:
  - Demands quantified additional, measurable vulnerability reduction
  - Encourages creative discovery of adaptation measures through market incentives: unleashes entrepreneurial spirit
- Pro-poor:
  - Encourages direct community engagement; could undercut bureaucratic barriers to directly helping poor
- Sustainability:
  - Credits awarded during, not prior to project start-up based on past climate vulnerability reduction

What is a VRC?

- A measure of the outputs of climate adaptation projects
- A single measure: a fungible unit crossing sectors/project types
- Issued for post hoc activity
- May be used with other evaluation tools
- VRC certificates are transferable, and a price may be put on them

VRC quantification's two premises:

1. Economic impacts correlation with vulnerability
2. Impacts can be equalized for poorer communities by factoring in per capita income

Institutional Structure:

- Higher Ground Foundation has created a VRC Standard Framework that has finished review by outside "experts group" and is being launched
- We are now launching our "Pilot Implementation and Partnership Phase" (PIPP) where projects will be eligible for "early action credit"

How are VRCs created?

Activity	Defined as:
Baseline Vulnerability Defined	Net projected change in asset or production base with climate changes: using downscaled climate outputs and economic impacts assessment
Intervention Impacts Assessed	Expert evaluation of how adaptation intervention reduces climate-induced changes to asset/production base
VRC Quantity Calculated	Based on anticipated assets/production protected/time divided by VRC factor
VRCs Issued Periodically	Based on % of project vulnerability reduction efficiency, from monitoring reports and 3rd Party Verification

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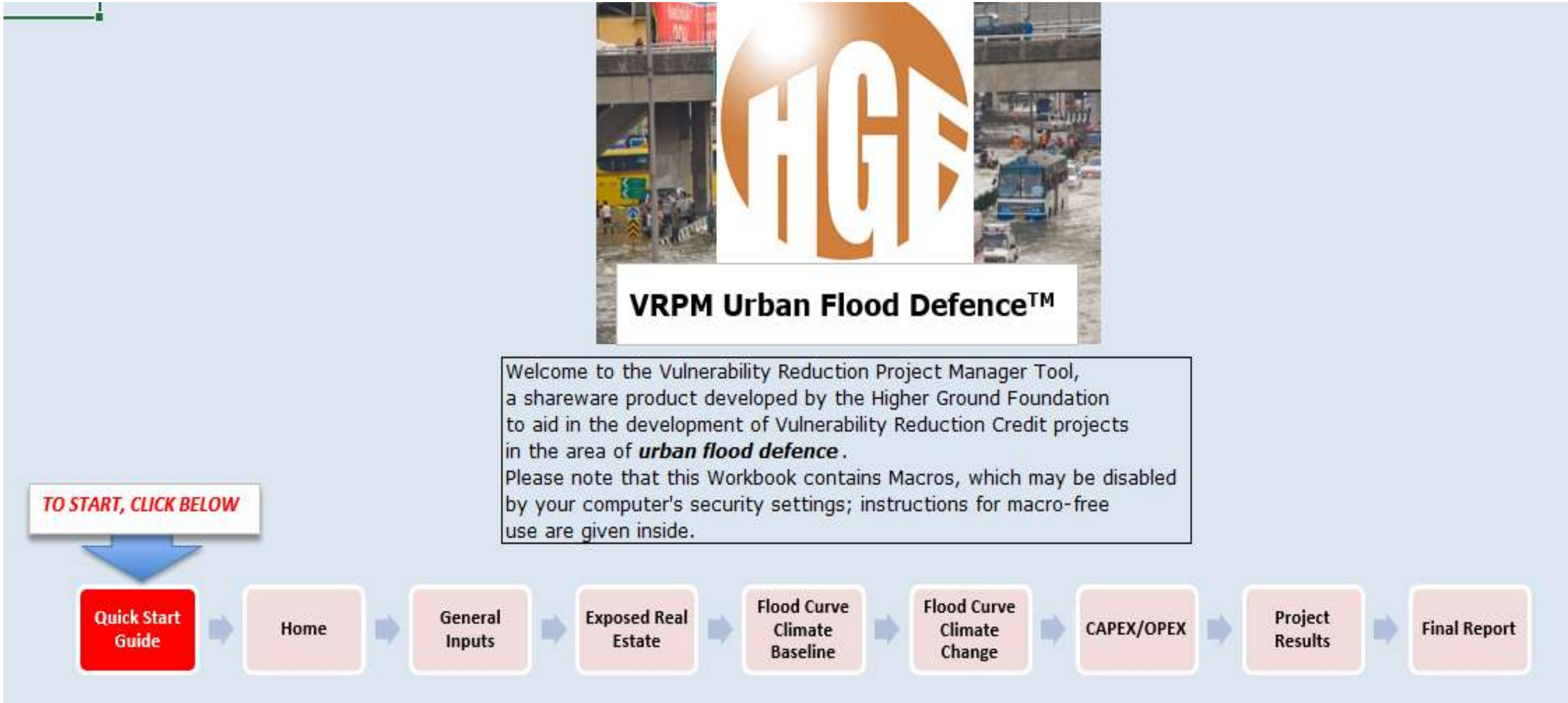
Vulnerability = Exposure x Sensitivity ÷ Adaptive Capacity

VRCs = (Avoided Impact x Income Equalization Factor) ÷ 50

E = Exposure	the total stock and flow in a system	= Impact Cost (Avoided)
S = Sensitivity	the potential for loss and damage to exposed stock and flows	
AC = Adaptive Capacity	the wealth, wealth generation capacity, cultural/social capital, governance	~ Inverse of Income Equalization Factor

The Vulnerability Reduction Project Manager (VRPM) Tool



The Vulnerability Reduction Project Manager (VRPM) Tool

MENU

Quick Start Guide → Home → General Inputs → Exposed Real Estate → Flood Curve Climate Baseline → Flood Curve Climate Change → CAPEX/OPEX → Project Results → Final Report

FILL IN THE *BLUE* CELLS ONLY

LOCATION OF THE PROJECT

Approximate Centre of Project	
Latitude (DD MM SS):	22° 09' 45" N
Longitude (DDD MM SS):	090° 25 13" E
Approximate Extent of Project	
NW Corner Lat (DD MM SS):	22°10'33.57"N
NW Corner Lon (DDD MM SS):	90°24'17.05"E
NE Corner Lat (DD MM SS):	22°10'35.14"N
NE Corner Lon (DDD MM SS):	90°25'29.93"E
SE Corner Lat (DD MM SS):	22° 9'15.90"N
SE Corner Lon (DDD MM SS):	90°25'29.09"E
SW Corner Lat (DD MM SS):	22° 9'12.16"N
SW Corner Lon (DDD MM SS):	90°24'18.14"E
or	
Approximate Radius of Project area (km):	

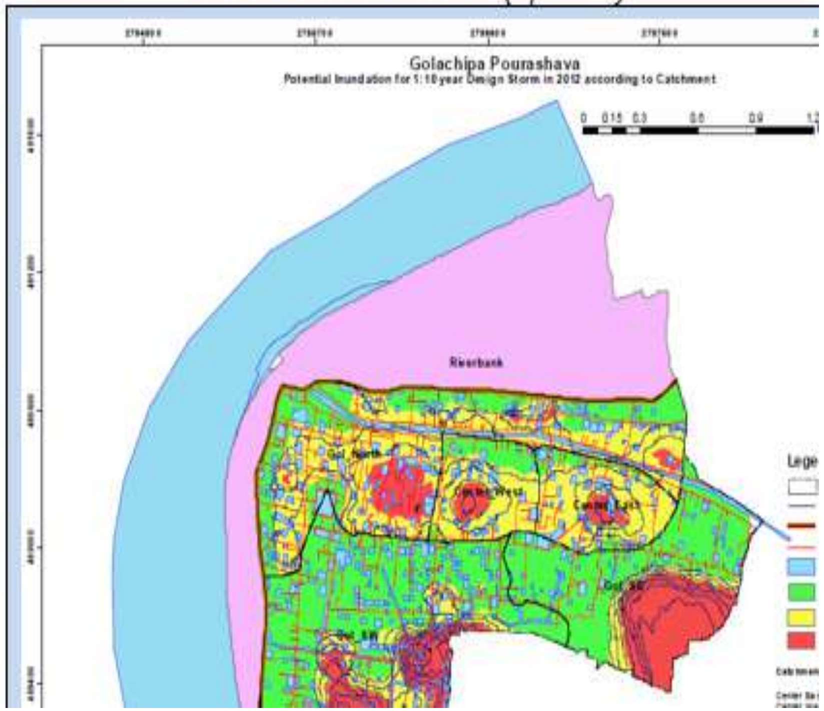
INPUT METHODOLOGIES

Input Specific Properties

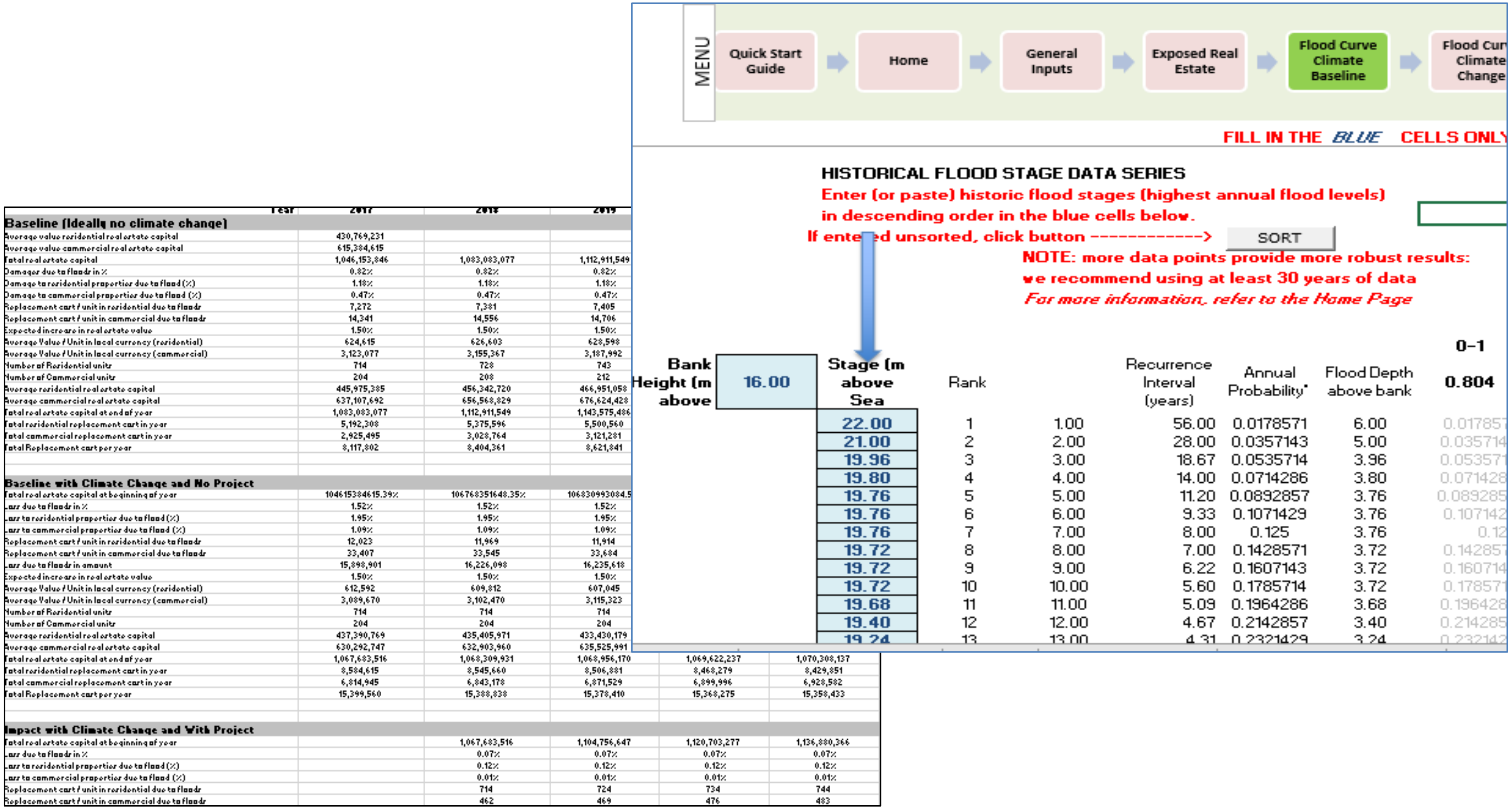
or

Input Digital Elevation areal data

MAP OF PROJECT AREA *(optional)*



The Vulnerability Reduction Project Manager (VRPM) Tool



Setting the scene

- Small subsistence agricultural community located on a river bank in Sahel
  - Millet, sorghum, rice, peanuts, tomatoes and livestock
  - Per capita income: $200/year
  - Houses “maison en banco” and “semi-dur”
  - Climate change induced increased severity and frequency of droughts and flooding

Flooding and Drought Impacts

Quantifiable Impacts:

→ Damage to houses, community spaces

→ Decline in crop and livestock yield

→ Decline in future income if livestock and/or land sold off

→ Health impacts: loss of productivity and/or medical costs (water-born disease, malnutrition, etc.)

→ Decline in household income

→ Children pulled out of school

→ Migration, potential to be permanent and social implications

Impacts Reduced By:

Photo: Cassandra Nelson/Mercy Corps

- Soil water retention
- Hedge crops
- Different crop varieties
- Drainage/flood control
- Flood resilient buildings and infrastructure
- Early weather warning systems

The Funding Problem:

- Cost prohibitive without external finance: €100,000

How VRCs will be generated by Project

Downscaled Climate Modeling Results

Damage Assessment Modeling

(Both Physical and Economic Cost/Benefit Modeling)

Project Impact Modelling

The

Proposed Project Activities

PROPOSED AND CURRENT ADAPTATION MEASURES	COSTS AND UNITS (IF AVAILABLE)
SINGLE COST STRUCTURAL MEASURES	
1. GABIONS (GABION)	$250/UNIT
2. CORDONS PIERREUX (STONE BARRIERS)	$65/200 M
3. DEMI-LUNES (HALF-MOON CATCHMENTS)	$230/HA
4. PLANTATIONS	$1,100/HA
5. BANQUETTES (DIKES)	$500/HA
ONLY THE SIMPLEST OF THESE MEASURES (I.E., CORDONS PIERREUX) HAVE BEEN DEVELOPED BY LOCAL PEOPLE; OTHERS ARE IMPLEMENTED BY INTERNATIONAL ORGANIZATIONS	
SINGLE COST AGRICULTURAL MEASURES	
1. IRRIGATED FORAGE CROP	
2. DIKES AGAINST RISING WATER	
NONSTRUCTURAL SINGLE COST MEASURES	
1. EARLY WARNING SYSTEM	
2. INTERDICTIONS CONSTRUCTION IN FLOOD ZONES	
3. FLOOD ZONE DELIMITATION	

How VRCs are Generated – The figures

	TOTAL DISCOUNTED CHANGE NET INCOME/WORTH OVER 20 YEARS (DISCOUNT RATE = 3%)
NO CLIMATE CHANGE, NO PROJECT	€20,270,700
CLIMATE CHANGE, NO PROJECT, (V_0)	€18,832,600
CLIMATE CHANGE, WITH PROJECT. (V_1)	€20,318,800
PROJECT COSTS	€100,000
AIC (AVOIDED IMPACT COSTS)	(V_2) - (V_1)= €1,486,200
IEF (INCOME EQUALIZATION FACTOR)	20 [BASED ON P.C. INCOME OF $200]
NO. OF VRC'S	(AIC (AVOIDED IMPACT COSTS) X IEF) / €50 = **600,000**
PROJECT COST PER VRC	€100,000 / 600,000 **= €0.16/VRC**
VRC "PRICE" OF €0.16+ REQUIRED	

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Please contact us if you would like to learn more!

شكراً

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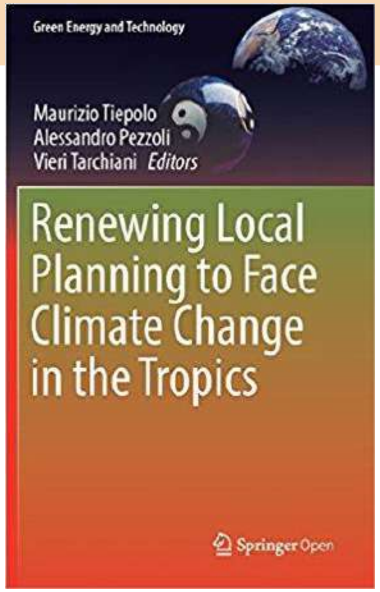
For more background including the case study, visit (open source): Chapter 16: "Addressing Climate Change Impacts in the Sahel Using Vulnerability Reduction Credits" in:



https://link.springer.com/chapter/10.1007/978-3-319-59096-7_17

MARRAKECH 2016
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UN CLIMATE CHANGE CONFERENCE

2ND EDITION OF THE INTERNATIONAL CONFERENCE ON ADAPTATION METRICS

Session 2_Protection against water hazards

MODELLING TO ASSESS WATER RESOURCES Case study: the Ouémé river basin (Benin), West Africa

Presented by
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National Institute of Water (INE)
University of Abomey-Calavi, BENIN

October 2017

OUTLINE

1. Introduction
2. Used Metrics
3. Discussion
4. Conclusion

1. INTRODUCTION (1/3)

Water is essential for life: Drinking, Sanitation, hygiene, health but also for agriculture, livestock, fishery, energy, industry, transport, …

And yet its universal access is still an issue;
Although people can suffer from lack of water, they may also be affected by the excess of water: floods.

The situation is worsened by factors like climate change (variability and availability of water), high population growth (reduction of the per capita water availability)

Therefore in order to face these challenges and better adapt to climate change, it is crucial to assess water resources and to insure a sustainable Integrated Water Resources Management (IWRM) and protection of people and goods;

1. INTRODUCTION (2/3)

Hydrological models: useful tools (scientific knowledge of processes; operational purposes; decision making; future; …)

In this study, we assessed water resources on the Ouémé river catchment at the outlet of Save in Benin

We used the MODHYPMA (Model based on the Principle of Least Action): climate variables as inputs and river discharges as outputs

In order to assess the performance of the model (capacity to reproduce observations), a number of metrics have been used

1. INTRODUCTION (3/3)

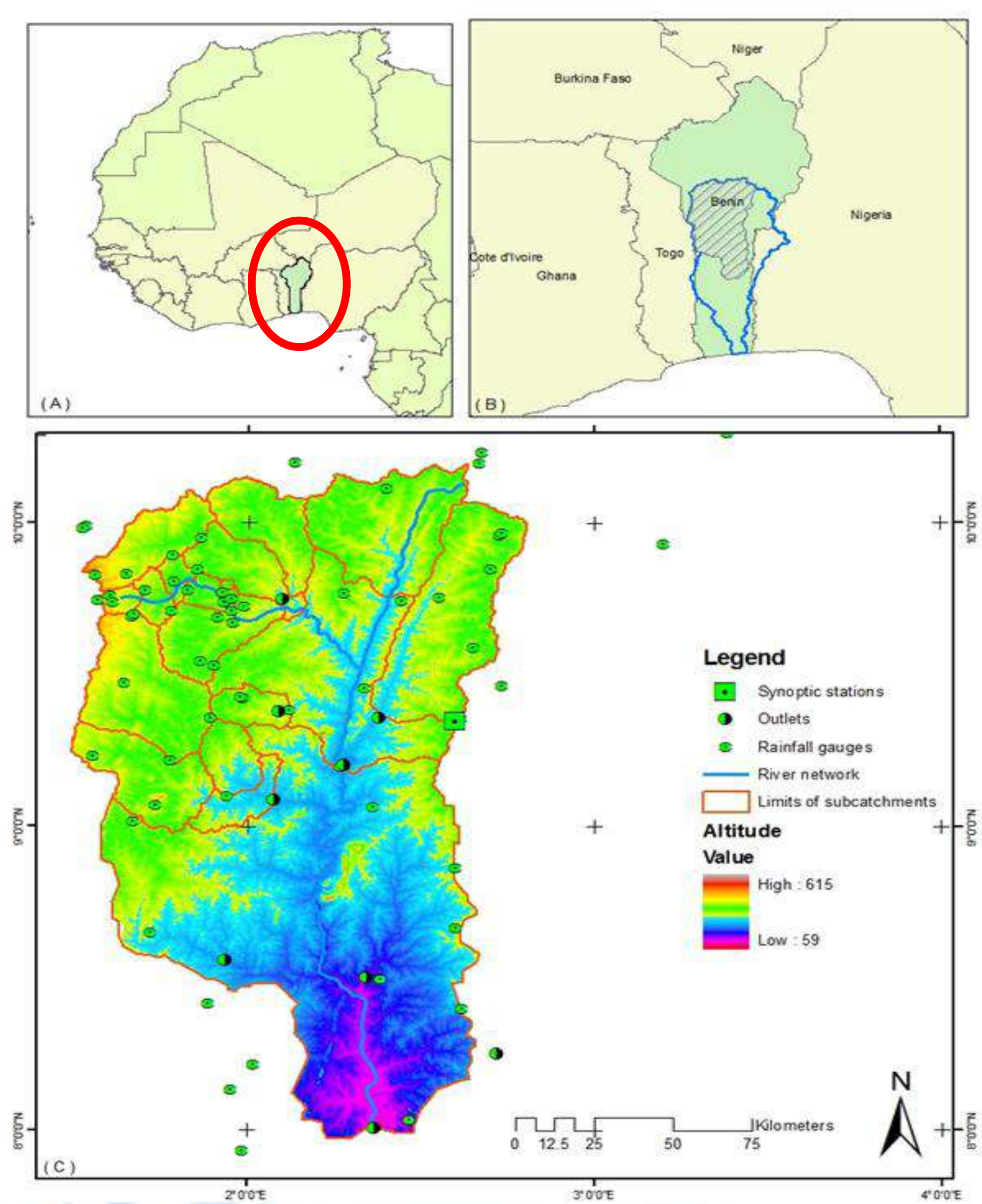


Figure 2-1: Location of sub-catchments of the Ouémé River basin.

❑<u>Location</u>: Ouémé basin with regard to Savè outlet (23 488 km^2) in Central Bénin.

❑<u>Climate</u>: wet and dry;

- unimodal: one rainy season April to October;
- mean annual precipitation (1960 – 2010): 1204 mm;
- mean annual temperature at Parakou station is 26.8°C

Introduction

Used Metrics

Discussion

Conclusion

2. USED METRICS (1/3)

Depending on the purpose of the modelling task:

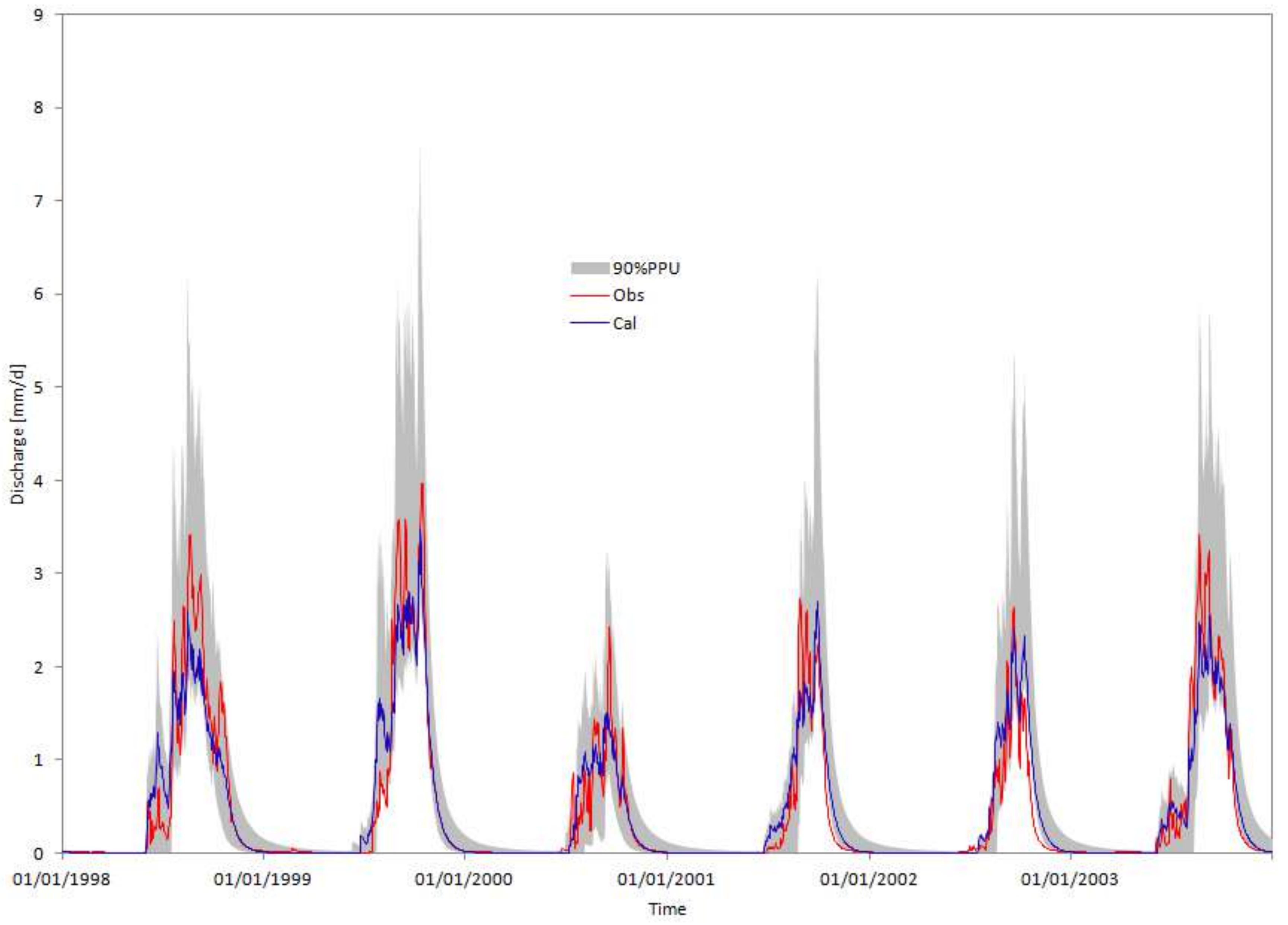
Numerical performance criteria (7) used=

- Nash-Sutcliffe efficiency (NSE) calculated on flows;
- NSE calculated on root squared transformed flows;
- NSE calculated on log transformed flows;

Si = simulated value for each time step, and Oi is the observed value

$$NSE = \frac{\sum_{i=1}^{N}(S_i - O_i)^2}{\sum_{i=1}^{N}(O_i - \bar{O})^2}$$

- NSE ranges from $]-\infty,+1]$
- NSE should be greater than 0.5 ; 1 means perfect match



The 90% confidence interval of daily runoff due to parameter uncertainty calculated by the GLUE method with a threshold of 0.65 for Bétérou catchment

2. USED METRICS (2/3)

- Percent Bias (PB) and Absolute Percent Bias (APBIAS) in %;

$$P.B. = \frac{\sum_{i=1}^{N}(S_i - O_i)}{\sum_{i=1}^{N} O_i}.(100) \qquad A.B.P. = \frac{\sum_{i=1}^{N}|S_i - O_i|}{\sum_{i=1}^{N} O_i}.(100)$$

PB should be between -5 and 5%; APB is positive and should not exceed 15%.

- Uncertainties: 90 percent prediction uncertainties (90 PPU) (see picture next slide)

•r-factor : relative width of the 90% uncertainty band

•p-factor: percentage of observations covered by the 90PPU

•p-factor is expected to be as close as possible to 0.9 while the r-factor is expected to be very small (close to zero).

2. USED METRICS (3/3)

- Sensitivity with respect to the performance measure NSE

$$S_i = \frac{P_{10} - M_{10}}{B}$$

Si = sensitivity index

Simple perturbation:

P10 = NSE for parameter value 10 % increased;

M10 = NSE for parameter value 10 % decreased;

B = NSE of the baseline simulation: parameter value unchanged.

Ranges for sensitivity indexes

Index	Sensitivity
< 0.05	Low
0.05-0.2	Medium
0.2-1.0	High
> 1.0	Very High

3. DISCUSSION (1/2)

	Metrics	Comments on Metrics	Values	Comments on values
1	NSE on flows	NSE is largely used although it tends to put more weight on larger values in a time series	0.82	Good
2	NSE on root squared transformed flows	NSE root tends to put more weight on mean values; more suitable for an all-purpose modelling	0.86	Good
3	NSE calculated on log transformed flows	NSE log tends to put more weight on lower values, more suitable to study low flows	0.85	Good
4	Percent Bias (PB)	PB gives a good estimate for the total but is insufficient alone	3.5%	Good
5	Absolute Percent Bias (APB)	APB complements PB	12%	Acceptable
6	r-factor	-	0.54	Good
7	p-factor	-	0.6	Good

3. DISCUSSION (2/2)

- In general, good metrics were obtained
- The main challenges here were related to the quantity and quality of the data in some areas of the basin

4. CONCLUSION

- Good values of metrics were obtained when modelling discharges on Ouémé river basin with MODHYPMA
- One metric is not generally enough and the choice of the metric depends on the purpose of the modelling task
- Metrics may be represented graphically where they can be appreciated visually

- More metrics may be used to confirm obtained results
- In order to obtain good metrics, it is important to have enough data and of good quality. That is why University of Abomey-Calavi is planning to extend the existing networks : we expect to implement new technology-equipments that would be more efficient and cheaper. But financial resources are needed.

PROJECT AND FUNDING

- WASCAL-UAC: West African Science Service Center on Climate Change and Adapted Land Use- University of Abomey-Calavi

- German Federal Ministry of Education and Research (BMBF)

Federal Ministry
of Education
and Research

PREVENTION DES RISQUES CLIMATIQUES
En Appui à l'ADAPTATION

Abdallah NASSIF
Directeur de la Météorologie Nationale

INTRODUCTION

Il est amplement établi que les phénomènes météorologiques à fort impact et les extrêmes climatiques, qu'ils surviennent brutalement, comme les ouragans, ou évoluent lentement comme les sécheresses, ont des effets dévastateurs partout dans le monde, qui entraînent des pertes en vies humaines, des personnes blessées, des déplacements de populations, et la destruction des moyens de subsistance et des biens. L'immense majorité des catastrophes, telles que les cyclones tropicaux, les tempêtes, les crues, les sécheresses, les feux incontrôlés et les vagues de chaleur et de froid, restent d'origine hydrométéorologiques.

En effet, pour la seule période couverte par le **Cadre d'action de Hyogo pour 2005-2015: Pour des nations et des collectivités résilientes face aux catastrophes**, les relevés montrent que **83 % des catastrophes , 39 % des décès , et 95 % de la population touchée ainsi que 70 % du montant total des dégâts ont été causés par des catastrophes naturelles** liées au temps, à l'eau et au climat . Le coût personnel et social de ces pertes et ses incidences financières sur l'économie sont considérables.

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October 6th and 7th 2017

Les changements observés se manifestent sur plusieurs plans: extrêmes, températures, précipitations, humidité, écoulements, ……

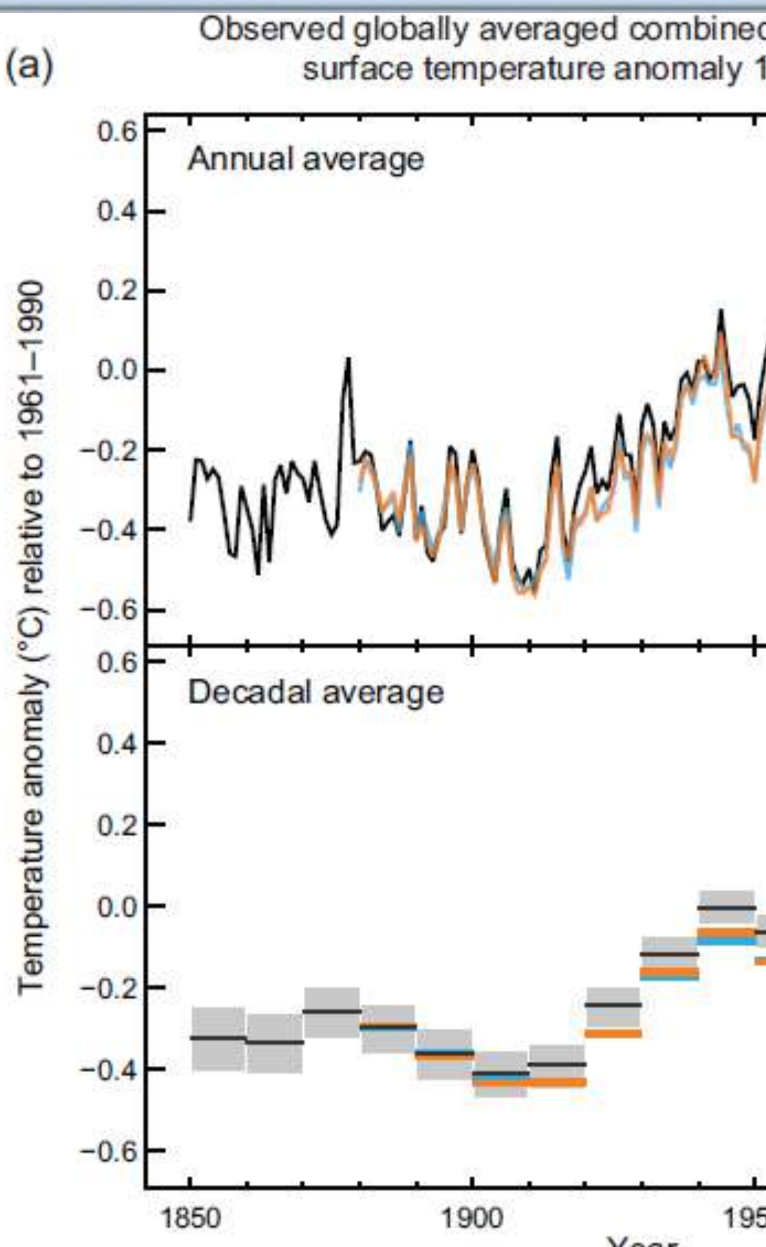


Figure 1: Change in annual average temperature in Africa, 1901–2012[20]

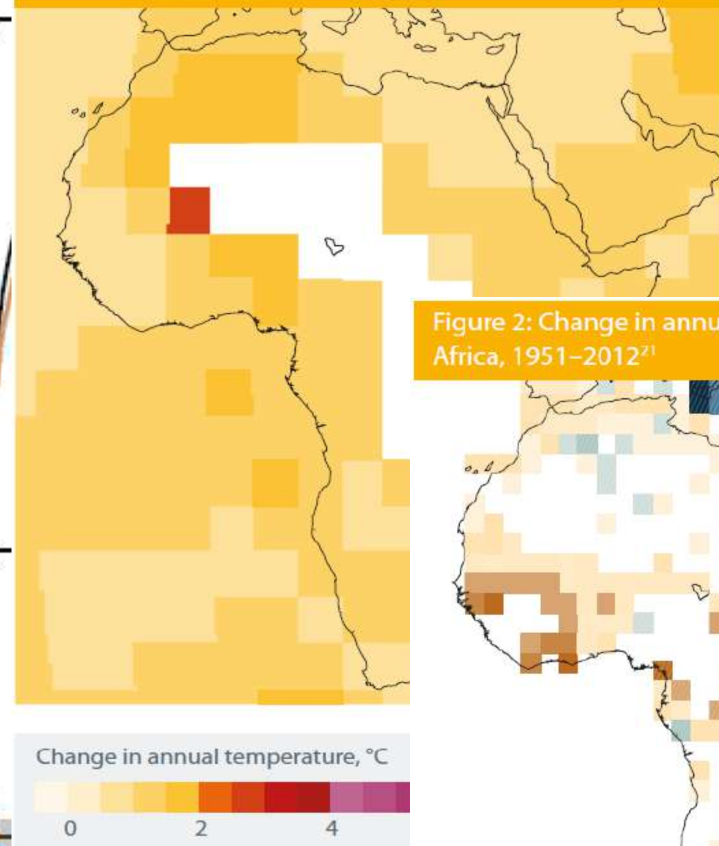
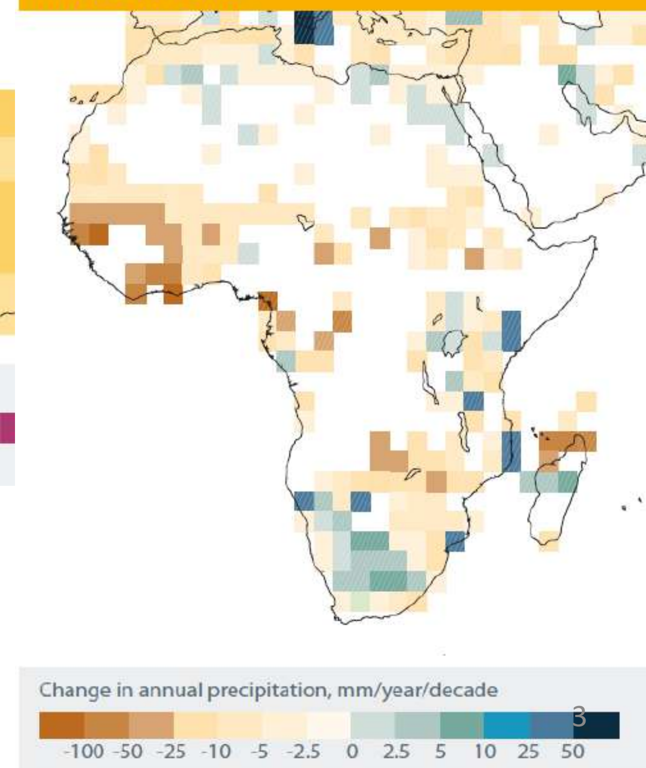
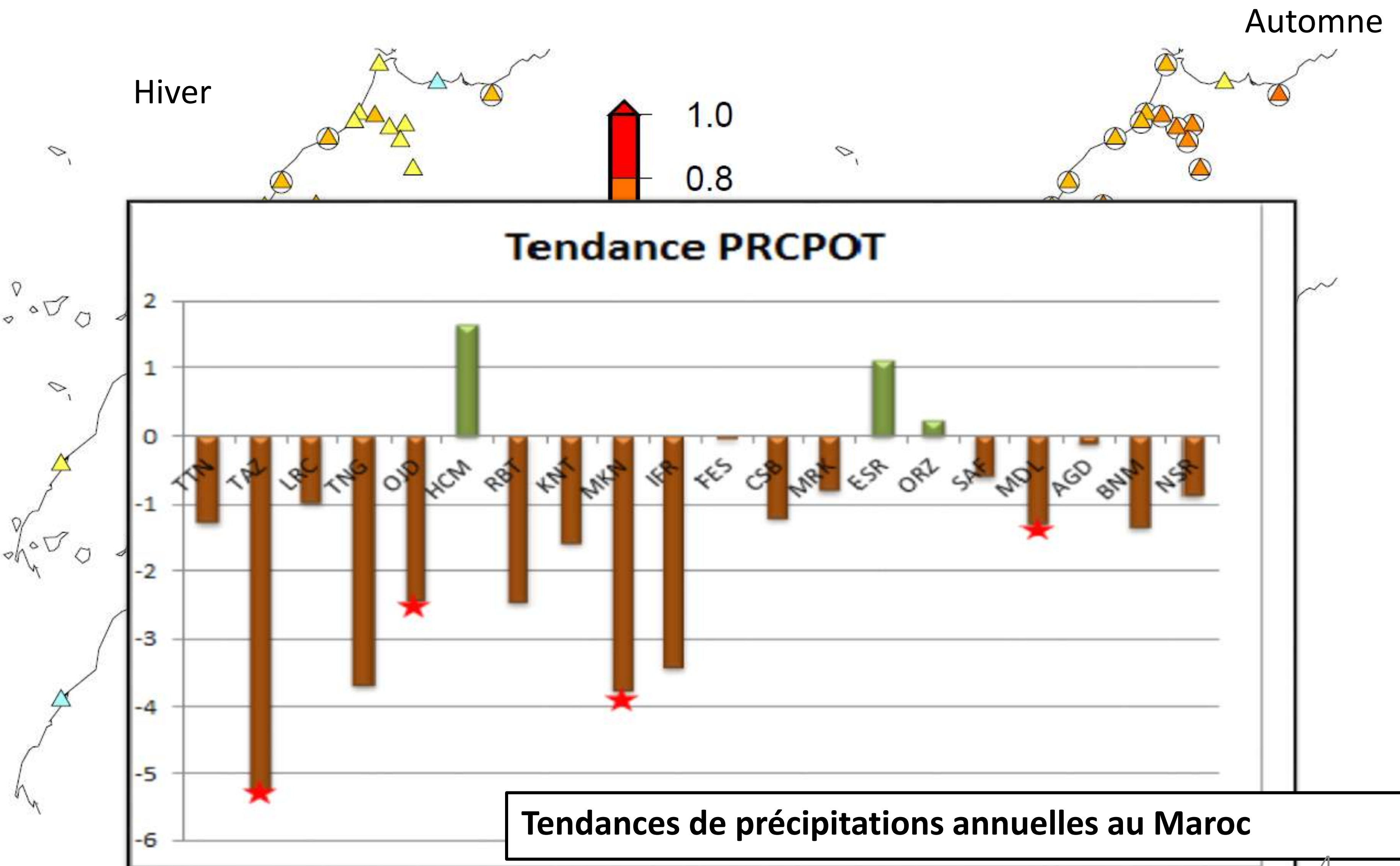


Figure 2: Change in annual average rainfall in Africa, 1951–2012[21]



Les changements observés au Maroc



Tendances de précipitations annuelles au Maroc

Records mensuels des températures maximales pendant l'année 2017

Station	nouveaux records		anciens records	
	T max abs	date	T max abs	date
Laayoune	39,8	31/03/2017	37,6	30/03/2005
Sidi slimane	40,2	18/04/2017	36,6	08/04/2011
Meknes	36,8	18/04/2017	36,3	26/04/1987
Fes-Saiss	37,8	18/04/2017	37,0	26/04/1987
Settat	36,6	18/04/2017	36,5	25/04/2008
Beni mellal	37,5	18/04/2017	37,4	26/04/1987
Essaouira	35,7	17/04/2017	35,0	12/04/1983
Tan tan	40,7	17/04/2017	40,2	03/04/2006
Smara	41,6	17/04/2017	41,5	30/04/2010
Larrache	42,9	17/06/2017	42,2	29/06/1968
Al hoceima	39,6	25/06/2017	37,7	13/06/1983

La valeur de 45,7 représente un nouveau records absolu sur Fès

Station	nouveaux records		anciens records	
	T max abs	date	T max abs	date
Larache	42,9	17/06/2017	42,2	29/06/1968
Sidi slimane	47,4	24/06/2017	47,0	29/06/2004
Agadir	46,7	24/06/2017	44,5	01/06/1937
Al massira	46,8	24/06/2017	46,4	25/06/2012
Taroudant	47,9	23/06/2017	46,0	28/2008, 26/2012
Dakhla	37,7	22/06/2017	33,2	06/06/1988
Meknes	45,9	12/07/2017	45,2	Juil 1920
Fes-Saiss	46,4	12/07/2017	44,7	21/07/2009
Taza	46,3	14/07/2017	46,0	31/07/2012
Fes-Saiss	45,7	07/08/2017	44,4	04/08/1985
Taza	45,7	04/08/2017	45,5	02/08/2012
Tan tan	47,6	07/08/2017	46,5	01/08/1988

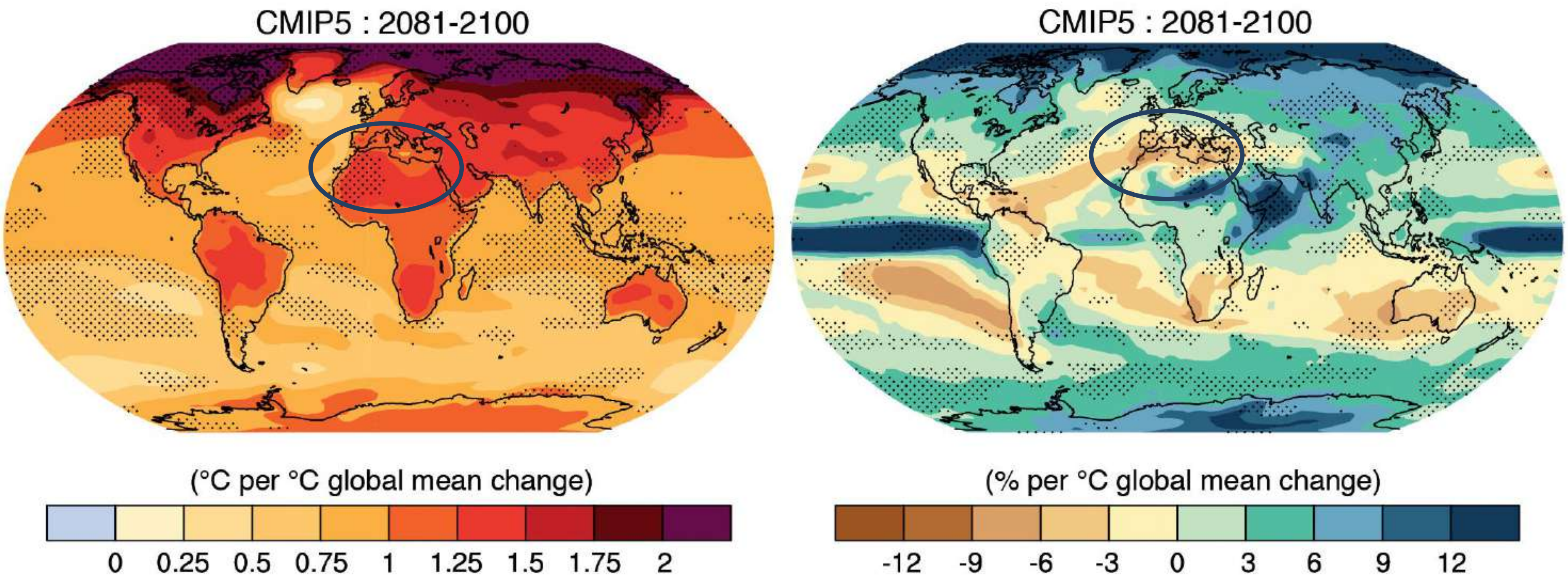
Records mensuels des pluies en 24 heures pendant l'année 2017

Station	nouveaux records		anciens records	
	Pluies en 24h (mm)	date	Pluies en 24h (mm)	date
Oujda	41,2	21 Janvier 2017	32,8	25 Janvier 2010
Essaouira	60	11 Février 2017	50	27 Février 2005
Agadir	91,9	11 Février 2017	59,3	01 Février 2009
Nador	48,6	19 Février 2017	45	16 Février 2001
Rabat	119,2	23 Février 2017	44,5	06 Février 2005
Al hoceima	19,2	30 Août 2017	11	18 Août 2010

La valeur **119,2 mm** représente un record absolu en 24 heures sur Rabat:

- 64mm entre 06h et 16h dont **44 mm en deux heures**:
- 26mm entre 14h et 15h.
- 18mm entre 15h et 16h.
- 55 mm entre 16h et 06h du lendemain.

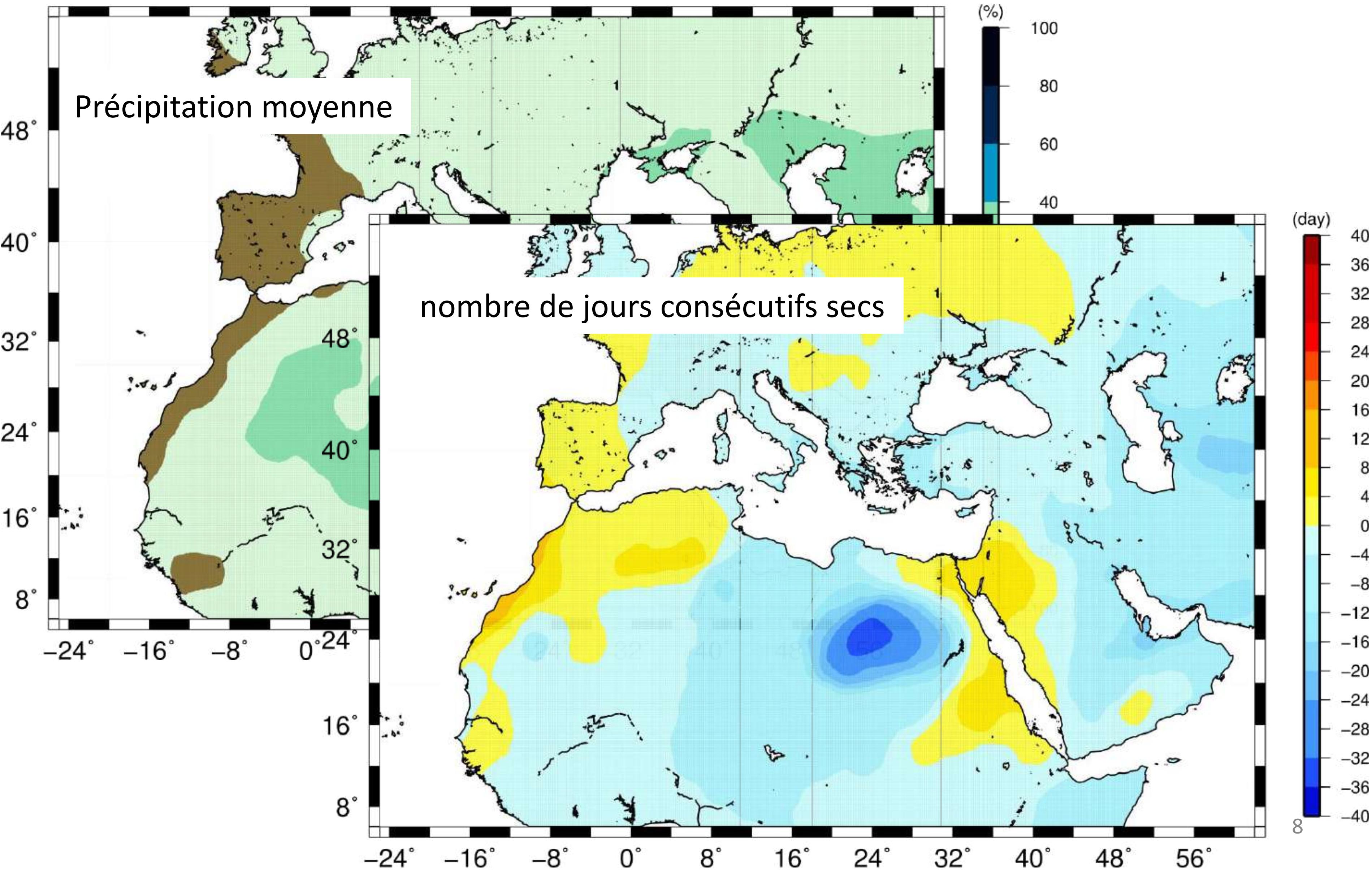
Changements futurs de températures et précipitations relatif au réchauffement global



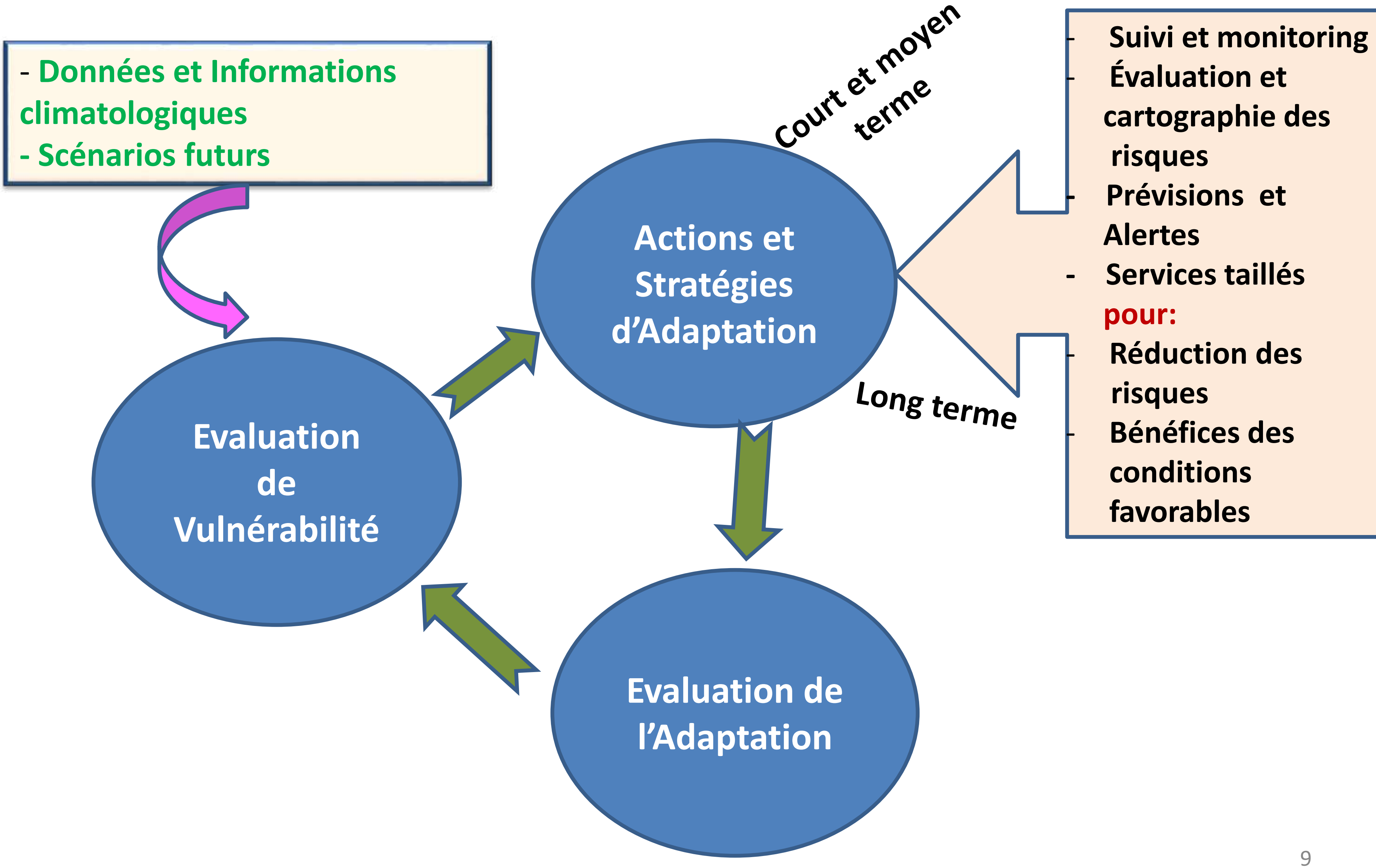
➔ Réchauffement en Afrique plus important que l'échelle globale

➔ Réductions de précipitations en zone méditerranéenne

Projections futures du climat à l'horizon 2036-2065 /1971-2000
sous le scénario RCP4.5
Précipitation moyenne et nombre de jours consécutifs secs annuels



Information climatique et lien avec l'adaptation

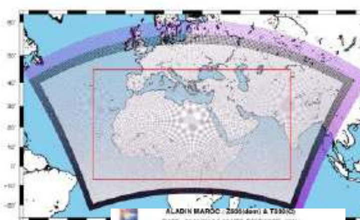
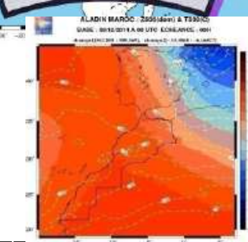


Types d’informations et services climatiques fournis par la DMN en appui à l’adaptation au niveau des secteurs

- Données Observations, Mesures
- Analyses et Produits climatologiques
- Analyses et Etudes
- Prévisions météorologiques
- Prévisions climatiques (saisonnière, …)
- Projections futures
- Produits spécifiques
- Information, Sensibilisation, Alerte
- Accompagnement ….
- …………

- Monitoring et vigilance
- Compréhension et Modélisation
- Gestion et réduction de risques
- Programmation et Planifications
- Optimisation
- Accès au financement
- ….



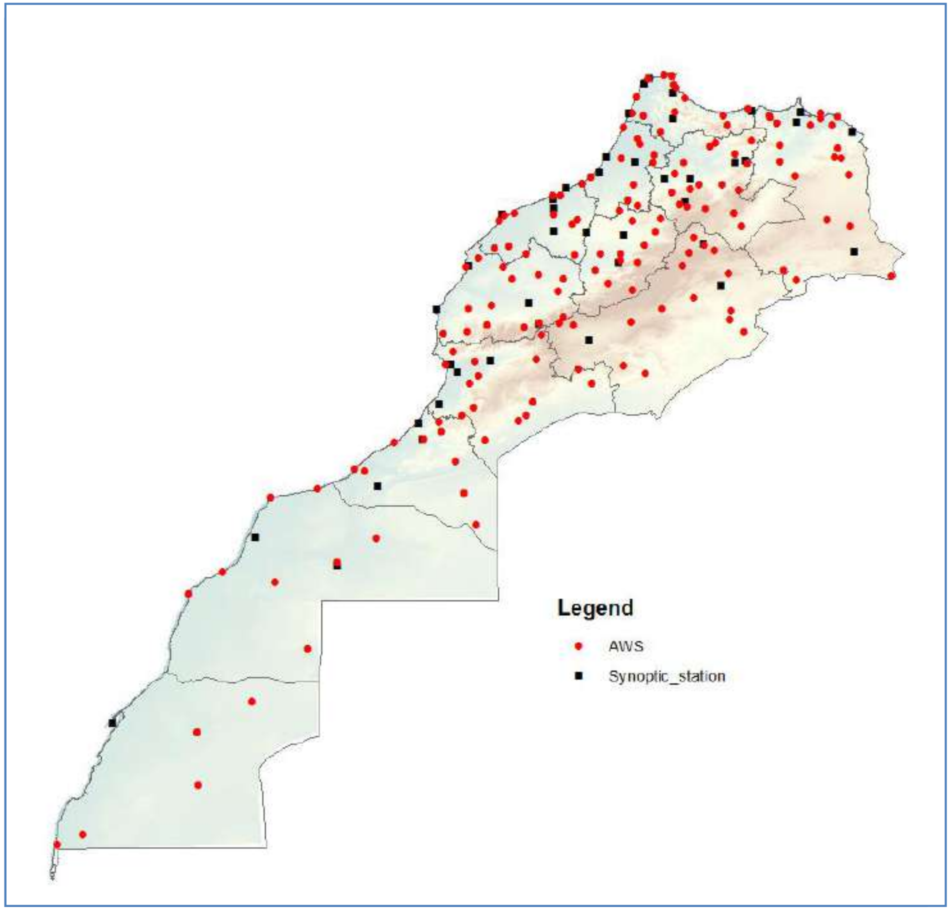





Observation et mesure à la DMN

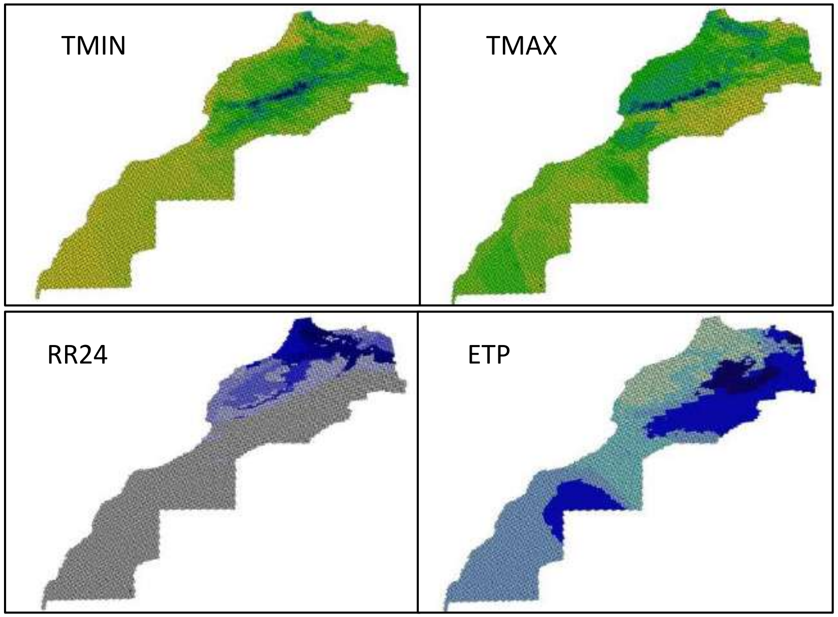
Réseau de surface de la DMN:

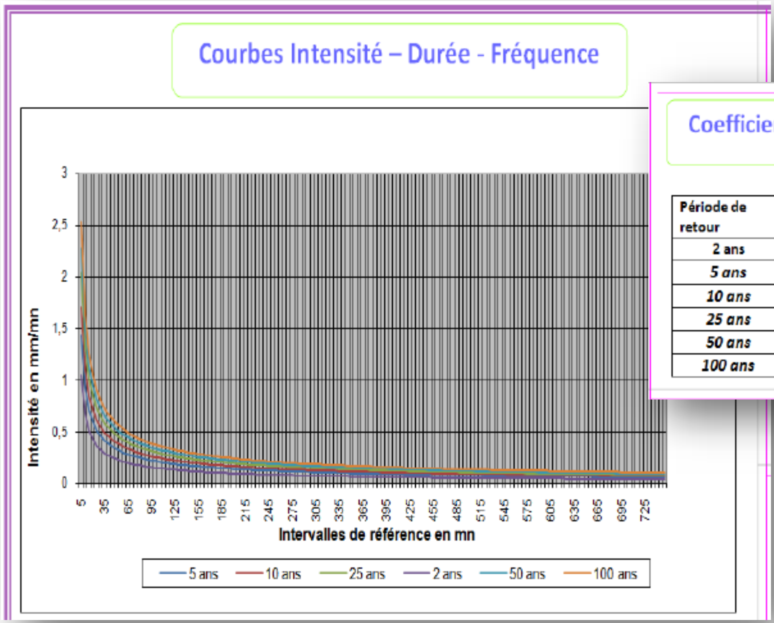
- *44 stations synoptiques*
- *5 stations maritimes*
- *156 stations automatiques*
- *528 postes climatologiques*
- *Réseau de 7 radars*
- *Un réseau foudre*
- *29 stations de qualité de l'air*
- *2 stations mobiles de qualité de l'air*
- *Une station d'ozone*
- *2 Stations de réception satellite*



Données climatologiques de base et produits élaborés

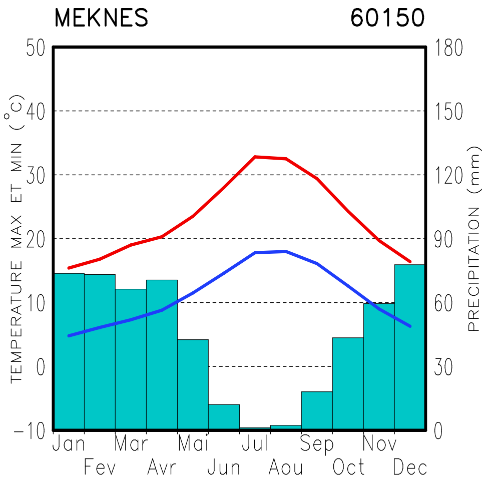
pour différents secteurs: Eau, Agriculture,...

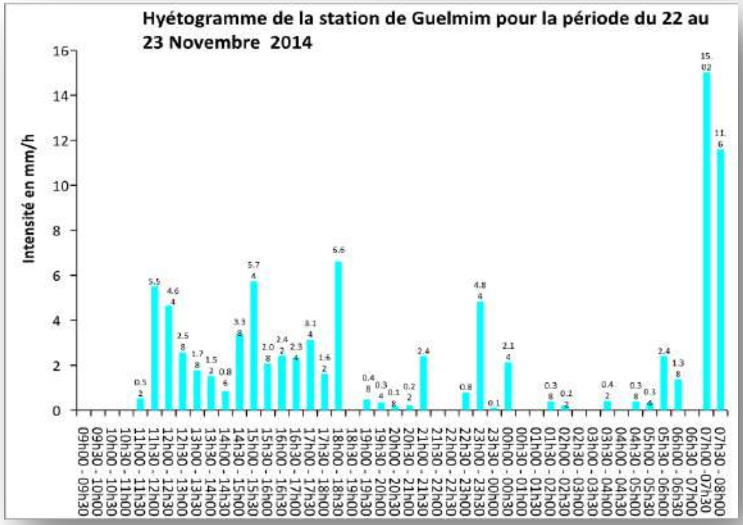


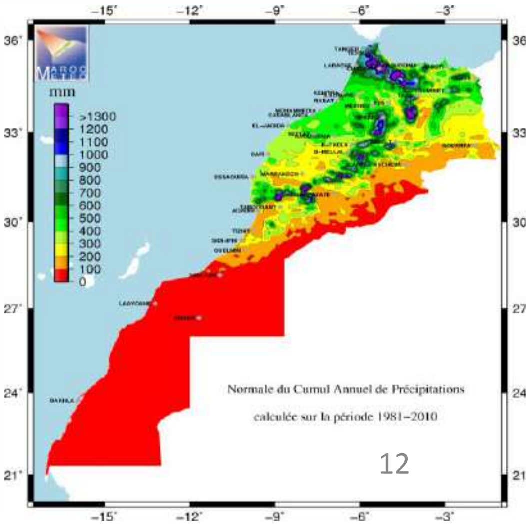


Coefficients de Montana

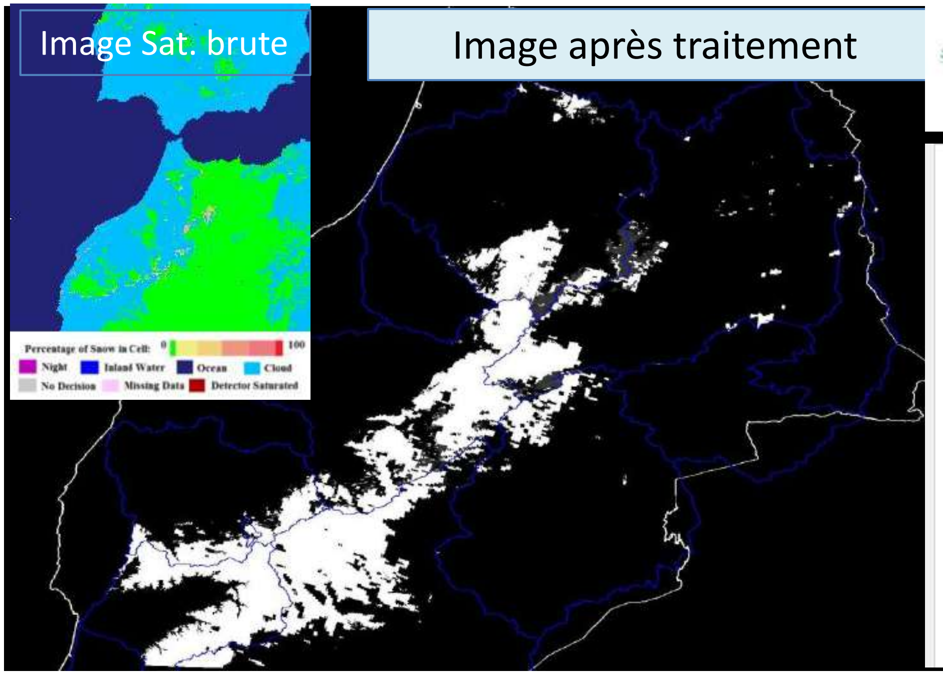
Période de retour	A	B
2 ans	2.950	0.647
5 ans	4.016	0.639
10 ans	4.745	0.638
25 ans	5.675	0.637
50 ans	6.368	0.637
100 ans	7.056	0.637

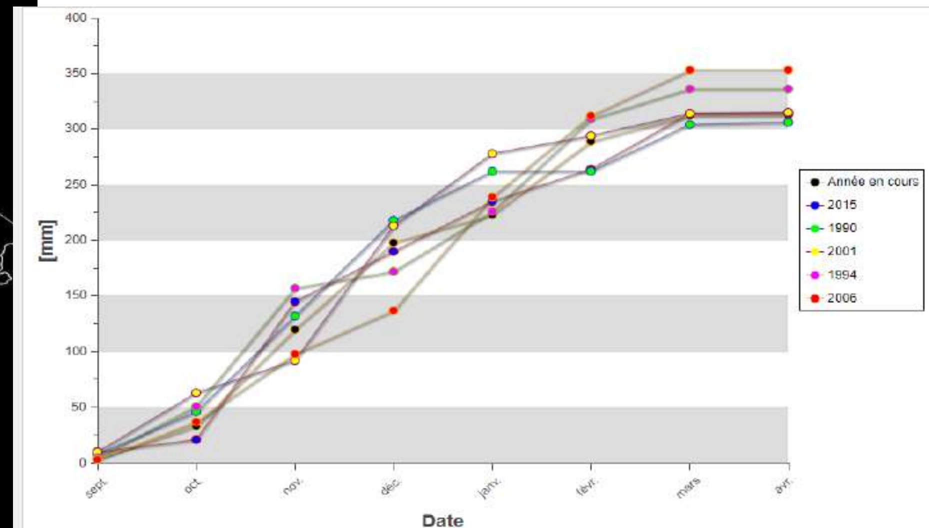




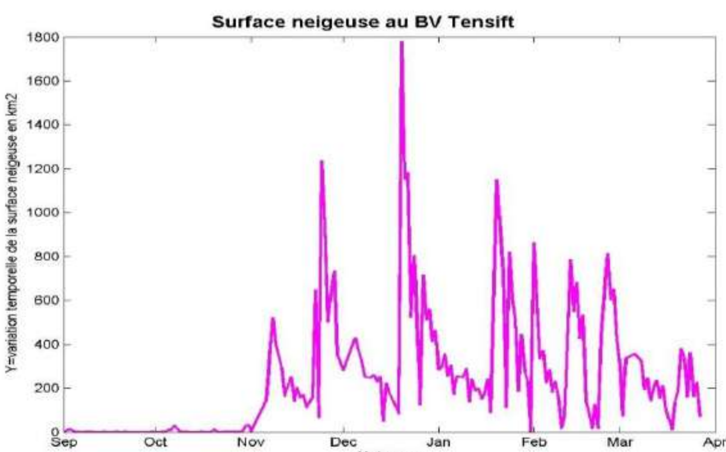


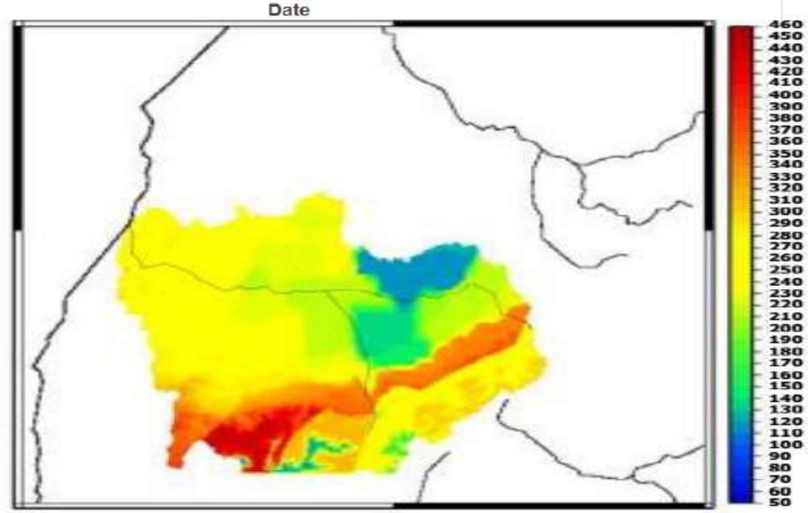
Produits spécifiques





Etendue de la surface neigeuse





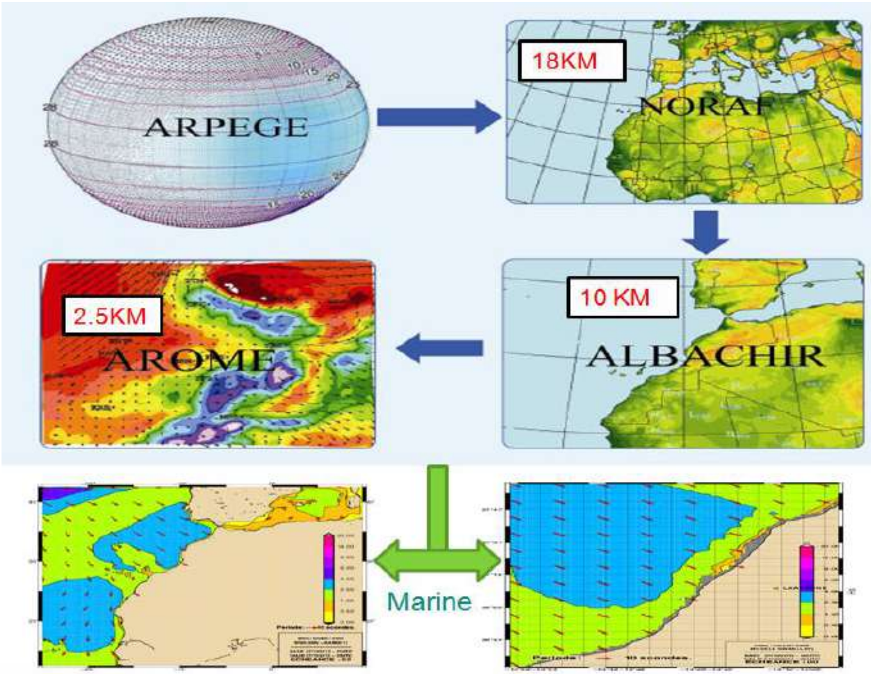
en collaboration avec les partenaires de LMI

Cumul annuel des précipitations liquides analysées par SAFRAN.

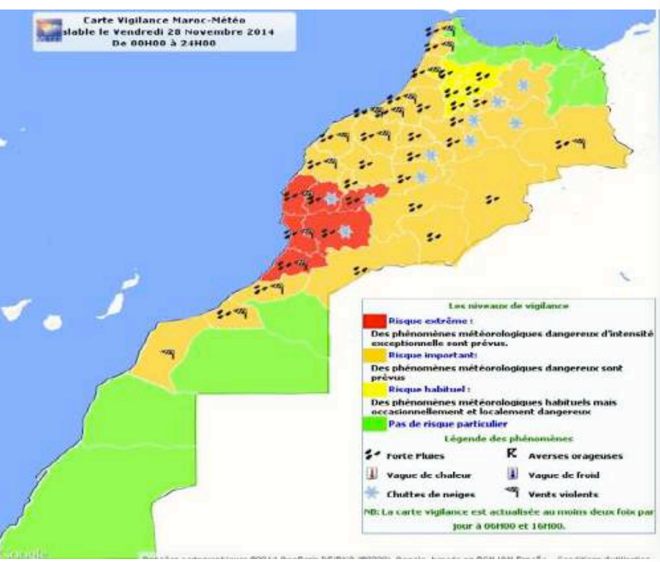
Prévisions et alertes à court et moyen terme

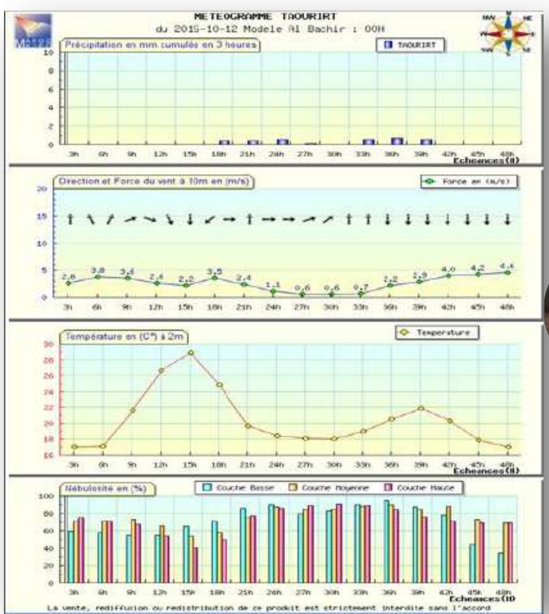
Différents modèles de prévision météorologique

- NORAF avec une résolution de **18 Km**
- ALBACHIR **10Km** de résolution
- AROME avec une résolution de **2.5 Km**
- Les sorties des modèles des centres météorologiques internationaux: Centre Européen de Prévision, Météo-France



➔ Différents produits





Planification à court terme
Gestion des risques
Prise de décision

Prévisions saisonnière ➔ adaptation à court terme

Ministère délégué auprès du Ministre de l'Energie des Mines de l'Eau et de l'Environnement chargé de l'Eau

Direction de la Météorologie Nationale

BULLETIN DE PREVISION SAISONNIERE

Precipitations & Temperatures

Issu en : Février 2016 Echéance : **Mars-Avril-Mai2016**

Nous présentons ci-après la prévision saisonnière issue du modèle dynamique global ARPEGE-Climat V5.2 couplé avec l'océan et opérationnelle à Maroc-Météo. Des prévisions d'ensemble de 27 membres sont alors produites chaque mois en combinant 9 analyses de l'atmosphère issues du CEPMMT à 3 analyses de l'océan issues du centre MERCATOR. On réalise ainsi une dispersion des conditions de démarrage afin de prendre en compte certaines des incertitudes liées à l'état initial.

A l'instar de ce qui se fait à l'échelle internationale, nous joignons aussi un ensemble de prévisions saisonnières dynamiques issues de centres météorologiques internationaux. Les évaluations faites sur nos régions sont encourageantes, cependant elles ne donnent pas à ce jour des scores comparables à ceux des régions pacifiques tropicales où le signal de prévisibilité est relativement important comme c'est le cas pour le phénomène EL NINO.

Nous exploitons également les sources de prévisibilité contenue dans les températures de surface de la mer (SST) par des méthodes statistiques. En effet, les SST évoluent lentement de manière prévisible et influencent significativement le climat. Signalons, cependant, que cet influence n'est pas la même d'une région à l'autre ni tout au long de l'année.

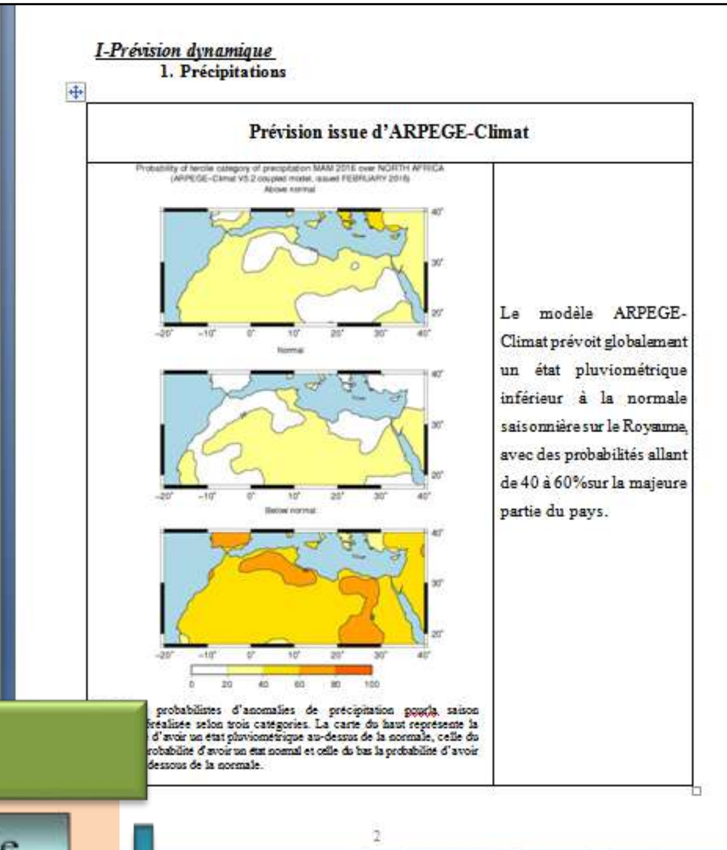
A noter :

1. *Nouveau : Prévisions statistiques sont élaborées à partir de mars 2014 pour les températures notamment pour les saisons qui montrent des scores intéressants.*
2. *Une nouvelle version du modèle ARPEGE-Climat à haute résolution (~55km sur le Maroc), est opérationnelle à Maroc-Météoà partir de Janvier 2014.*
3. *Toutes ces prévisions sont élaborées à titre expérimental*

SYNTHESE

L'analyseglobale des aspects climatiques et de l'ensemble des prévisions de précipitations et de températures issues de différents modèles donne pour la saison Mars-Avril-Mai 2016:

- Pour les Températures:
  - Un état probablement supérieur à la normale sur le Royaume



I-Prévision dynamique

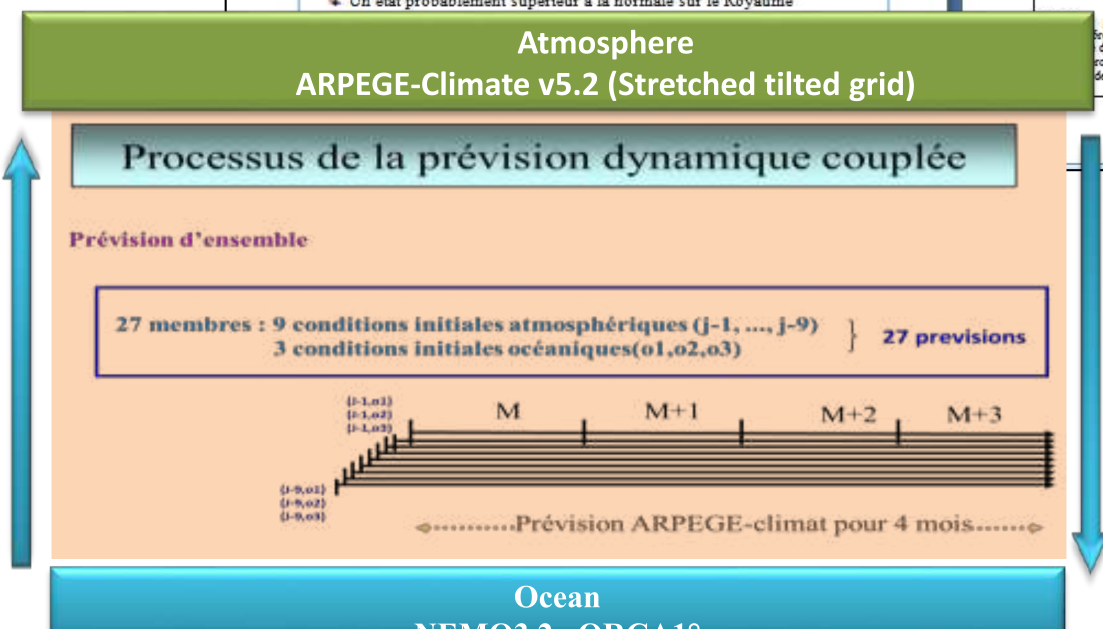
1. Précipitations

Prévision issue d'ARPEGE-Climat

Le modèle ARPEGE-Climat prévoit globalement un état pluviométrique inférieur à la normale saisonnière sur le Royaume, avec des probabilités allant de 40 à 60%sur la majeure partie du pays.

probabilistes d'anomalies de précipitation pourla saison réalisée selon trois catégories. La carte du haut représente la d'avoir un état pluviométrique au-dessus de la normale, celle du robabilité d'avoir un état normal et celle du bas la probabilité d'avoir dessous de la normale.

2



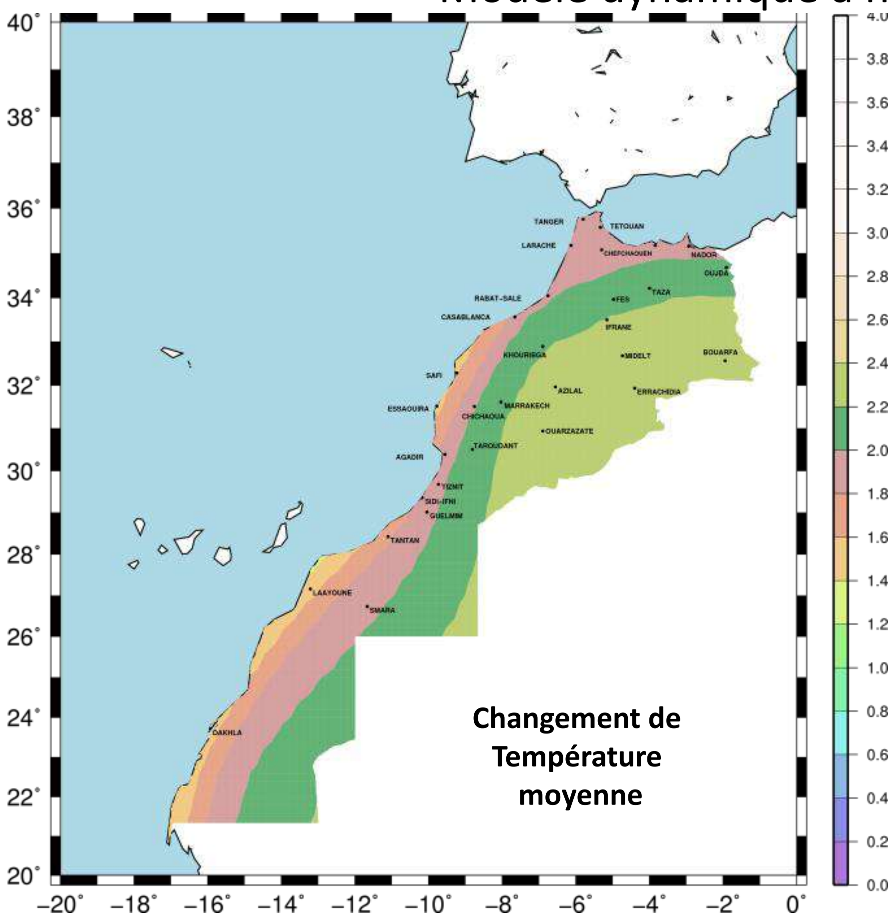
➔ **Intégration pour la prévisions des ressources en eau**

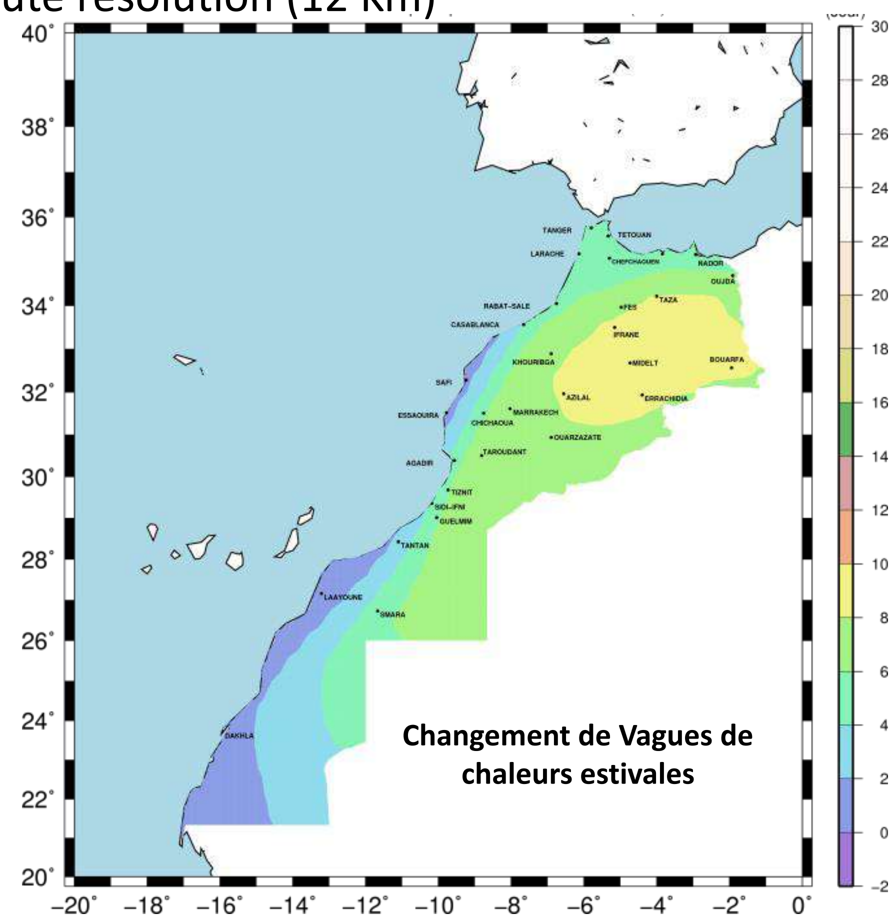
➔ **Intégration pour la prévision des récoltes**

➔ **Intégration pour la prévention des risques**

Prévisions climatiques: changements futures
➔ Evaluation des impacts et inputs pour l'adaptation

Modèle dynamique à haute résolution (12 Km)

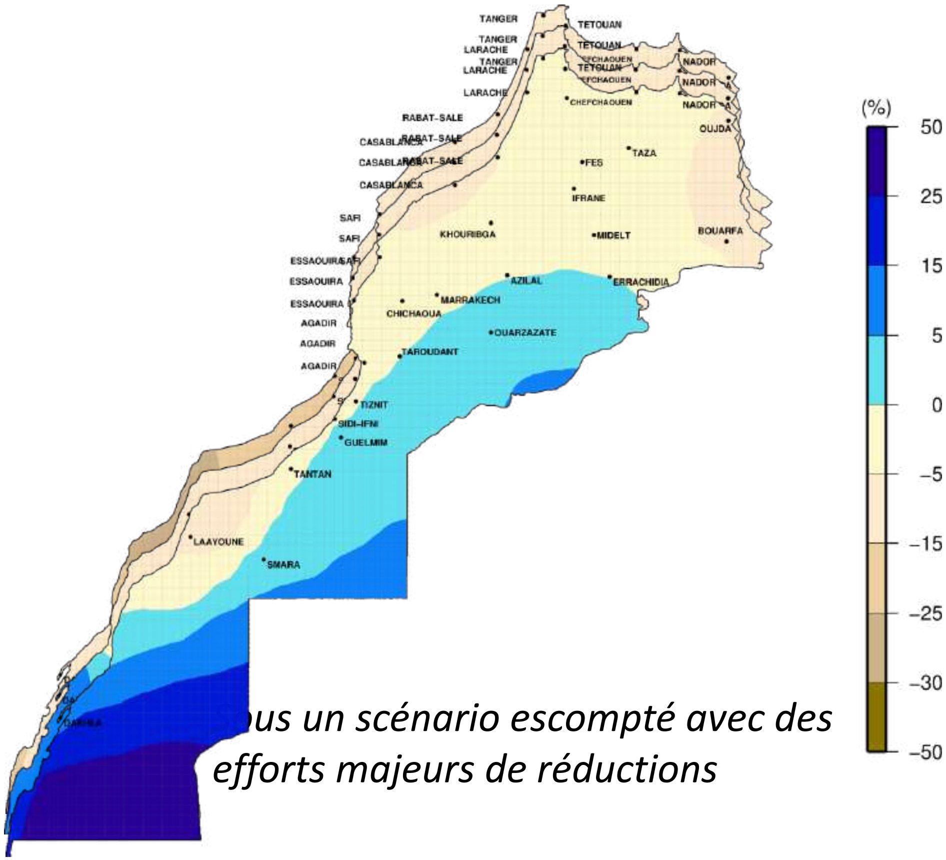




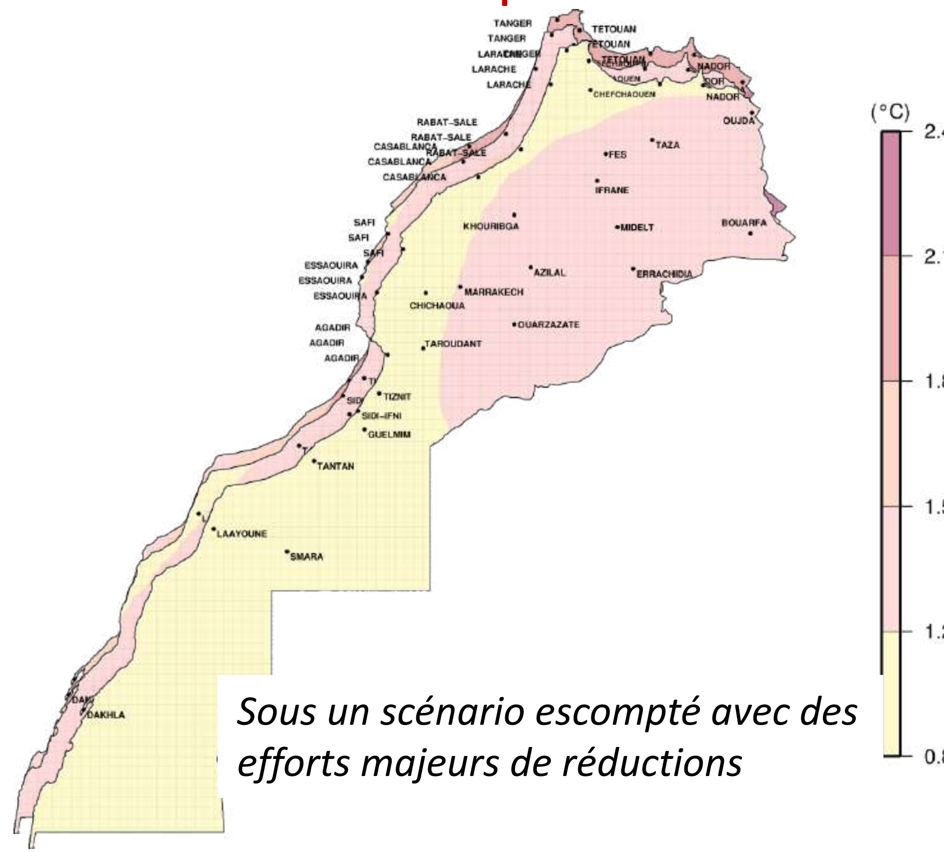
Changements futurs projetés sur le Maroc à l'horizon 2050 sous le scénario RCP8.5

Changements futurs des précipitations et températures annuelles moyennes du Maroc selon les scénarios d'émissions du GIEC (RCP8.5, RCP4.5,RCP2.6)

Précipitations



Température



Changements futurs des précipitations annuelles moyennes projetés sous les scénario RCP pour l'horizon 2050 (2036-2065 comparé à la période de base 1971-2000).

Changements futurs des températures moyennes annuelles projetés sous les scénarios RCP pour l'horizon 2050 (2036-2065 comparé à la période de base 1971-2000.

Certification ISO 9001 V2008

- Une reconnaissance officielle pour la qualité et la performance des prestations et services mis à disposition de ses partenaires et ses usagers.

- Renforcer la position de la DMN à l'échelle internationale.

- Elle constitue également un gage de reconnaissance de fonctionnement de la DMN en respect des pratiques et standards internationaux.

BUREAU VERITAS
Certification

BUREAU VERITAS 1828

Direction de la Météorologie Nationale (Maroc Météo)

Boulevard du Complexe Administratif, Hay Hassani. BP 8106 Casa Oasis.

Casablanca, Maroc.

Bureau Veritas Certification Certifie que le système de management de l'organisme susmentionné a été audité et jugé conforme aux exigences de la norme :

Standard

ISO 9001 : 2008

Domaine d'activité

- Contribuer à la sécurité des personnes et des biens par la mesure, l'observation, la prévision et la veille météorologique, climatologique et environnementale ;
- Assurer l'assistance météorologique à la navigation aérienne et maritime ;
- Concevoir et développer les produits en relation avec les domaines de la météorologie, de la climatologie des changements climatiques et de l'environnement pour les besoins des secteurs socio-économiques.

- المساهمة في حماية الأشخاص والممتلكات عن طريق توفير خدمات القياس ، الملاحظة ، التوقعات الجوية والسهر الرصدي والمناخي و البيئي ،
- ضمان المواكبة والدعم الرصدي لمجالي الملاحة الجوية والبحرية،
- تصميم و تطوير جميع المنتوجات المرتبطة بميادين الأرصاد الجوية : الرصد الجوي ، المناخ ، التغيرات المناخية و البيئة، لتلبية مختلف حاجيات القطاعات الاقتصادية والاجتماعية

- Contribute to the safety of persons and property by measuring, observing, weather forecasting and climate monitoring;
- Ensure meteorological services to aviation and marine activities ;
- Design and develop the products in relation to the fields of meteorology, climatology, climate change and the environment to the needs of socio-economic sectors.

Date de début du cycle de certification: **03 Septembre 2014**

Sous réserve du fonctionnement continu et satisfaisant du système de management de l'organisme, ce certificat est valable jusqu'au: **02 Septembre 2017**

Date originale de certification : **03 Septembre 2014**

Affaire n° : 8362044 **Date : 10 Septembre 2014**

Omar BENAICHA
Directeur Général

Patrick LIBIHOUL
Vice-Président Nord-Ouest
et Afrique Centrale

Adresse de l'organisme certificateur : Bureau Veritas Maroc – 7, boulevard de la résistance, 20 310 Casablanca - Maroc

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Des informations supplémentaires concernant le périmètre de ce certificat ainsi que l'applicabilité des exigences du système de management peuvent être obtenues en consultant l'organisme. Pour vérifier la validité de ce certificat, vous pouvez téléphoner au : 00 212 522 543 540.

Alimentation en information climatique et participation aux études d’évaluation d’impacts pour la mise en place des stratégies d’adaptation

Figures IVa et Figure IVb : Impacts des changements climatiques sur le rendement du blé dur pluvial au Maroc. IVa : impacts modérés jusqu'en 2030 et sévères au-delà, selon le scénario A2 ; **IVb :** impacts modérés jusqu'en 2030, et maîtrisés au-delà, selon le scénario B2.

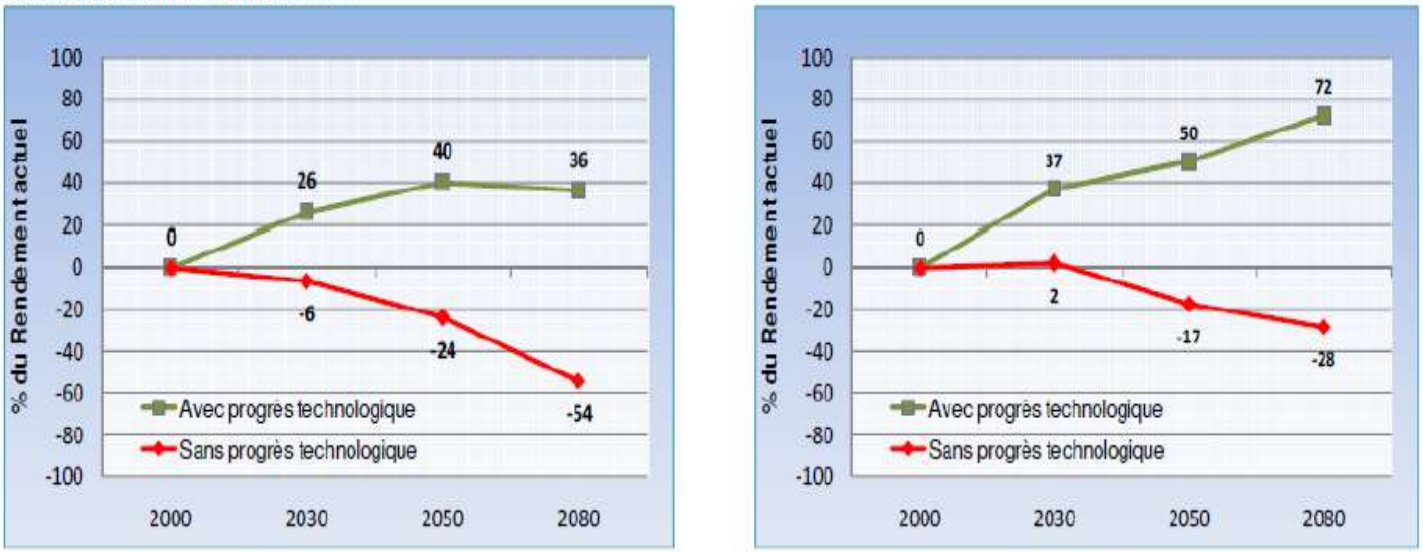
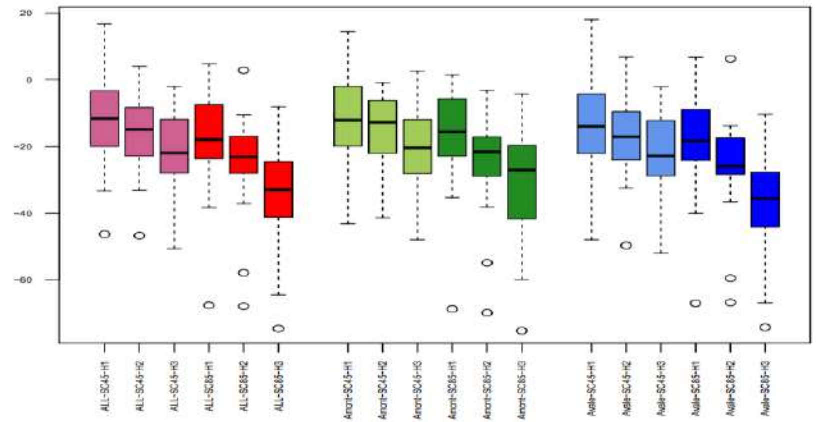
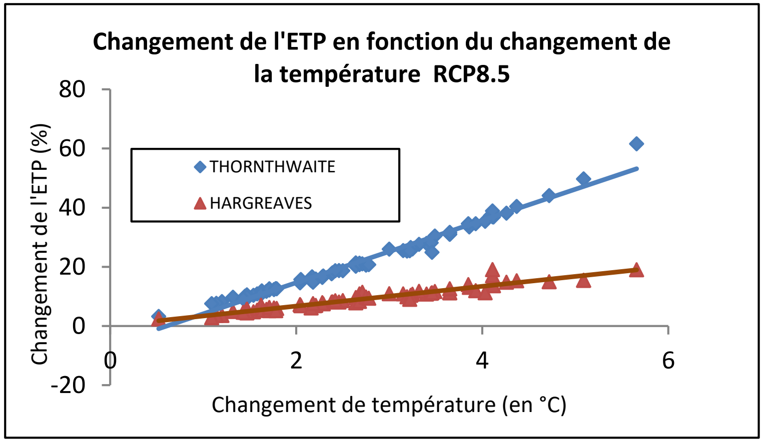


Figure Iva

Figure IVb

Appui à l’adaptation du secteur de l’eau





Vers des Métriques pour l'adaptation

➔Une adaptation efficace d'un secteur doit permettre de réduire sa vulnérabilité aux CC et renforcer sa résilience

➔L'adaptation a des limites et peut ne

des CC

Les services climatiques, incontournables, ont un apport important en matière de gestion de risque, de réduction de la vulnérabilité et d'adaptation au CC

de mesure de

aux de résistance face aux extrêmes climatiques

- Absorption des conditions défavorables persistante (exple: sécheresse)
- Bénéfice et optimisation en conditions favorables

INTERNATIONAL CONFERENCE ON
ADAPTATION METRICS FOR WATER & AGRICULTURE

Climate change and water valuation in Souss-Massa region Morocco): Which management and adaptive measures.

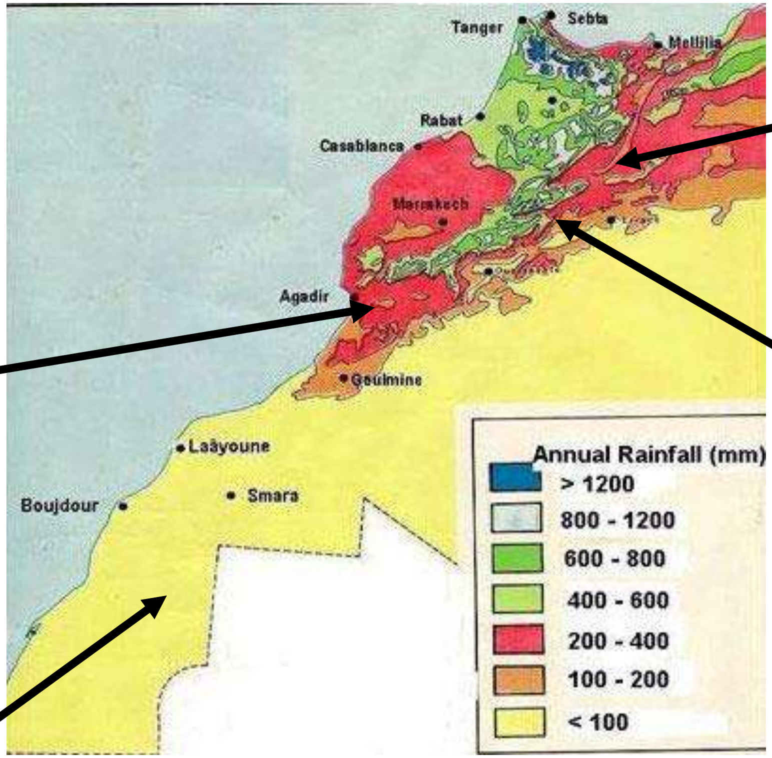
Lhoussaine Bouchaou

Applied Geology and Geo-Environment Laboratory, Ibn Zohr University, Faculty of Science, Agadir, Morocco

In collaboration with
Hassan II Institute of Agronomy and Veterinary Medicine, Morocco,
International Center for Biosaline Agriculture, Dubai, UAE
Souss-Massa-Drâa Hydraulic Basin Agency, Agadir, Morocco,
IRD
ORMVASM
Email : l.bouchaou@uiz.ac.ma, lbouchaou@gmail.com

WASA Project

Water crisis in Morocco: low precipitation and overexploitation

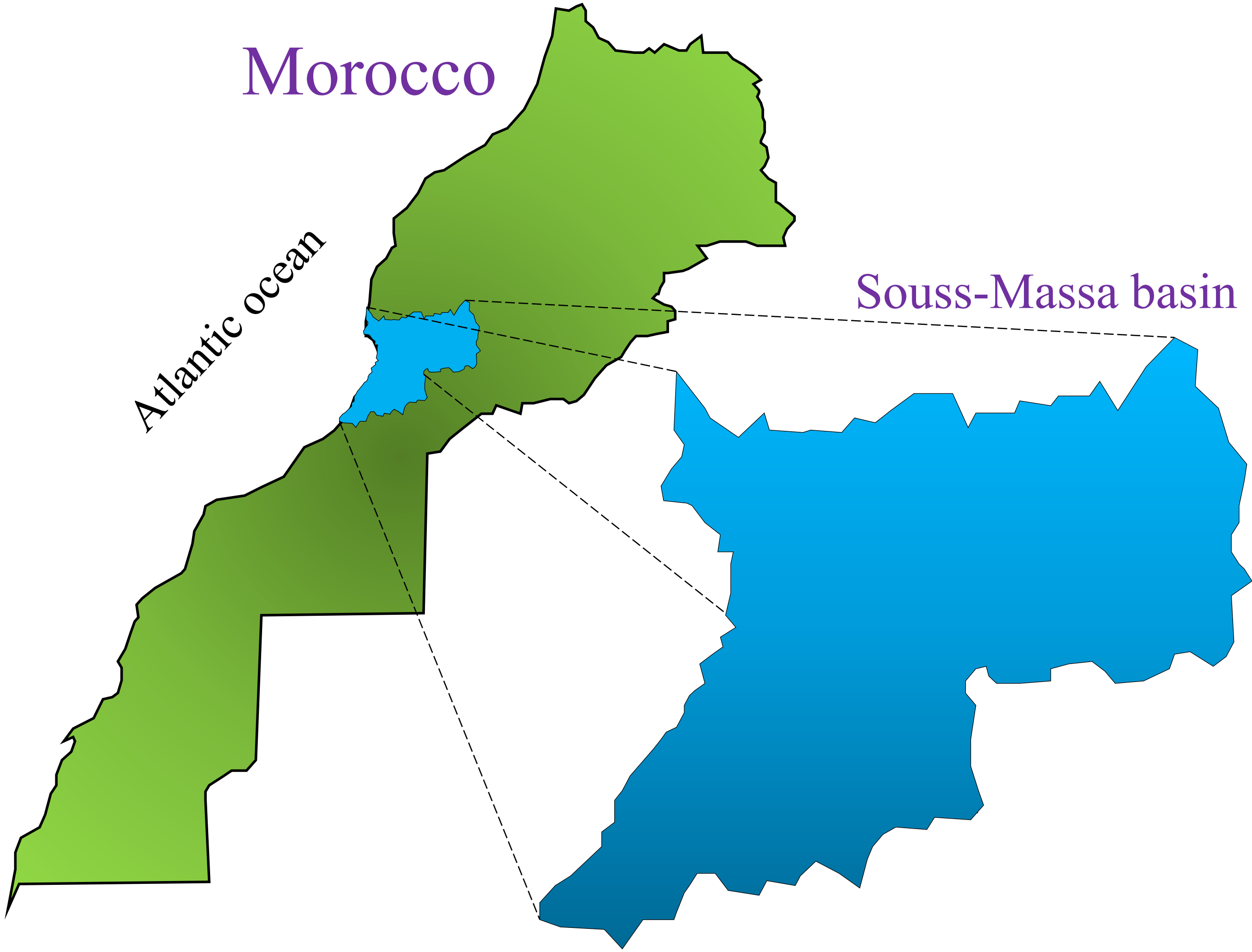


Climate change models

⇩

intensification of recurrences of droughts

WASA Project



Basin characteristics

- 6 Provinces
- Total surface area: 28.000 km²
  (4.5% national area)
- Population 2.33 millions (54% rural, 46% urban)
- 3 principal activities: Agriculture, tourism et Fishery.
- Climate arid to semi arid (200 mm/y)
- One of the main economic pole

Agricultural Production
- 85% of fresh vegetable export of Morocco
- 50% of citrus export of Morocco
- 50 Million working days

Tourism: + 1 million of tourists per year

Questions to be asked

- **Main issues of water management**

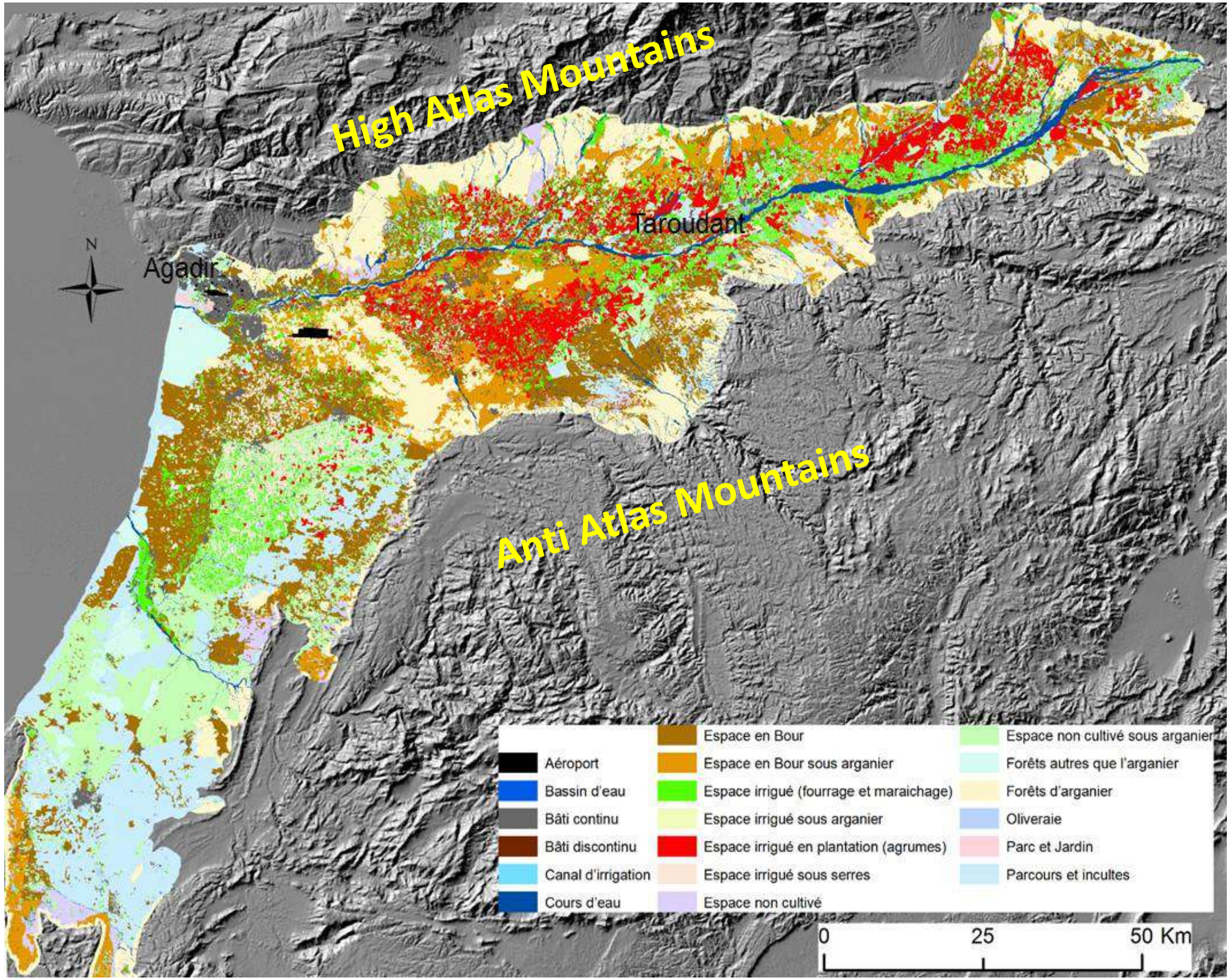
- ➢ **Who uses water?**
- ➢ **How much is used?**
- ➢ **For what uses?**

- ✓ **Who makes the decisions?**
- ✓ **What volumes?**

How to evolve from a conflict situation to a partnership situation?
Which governance?

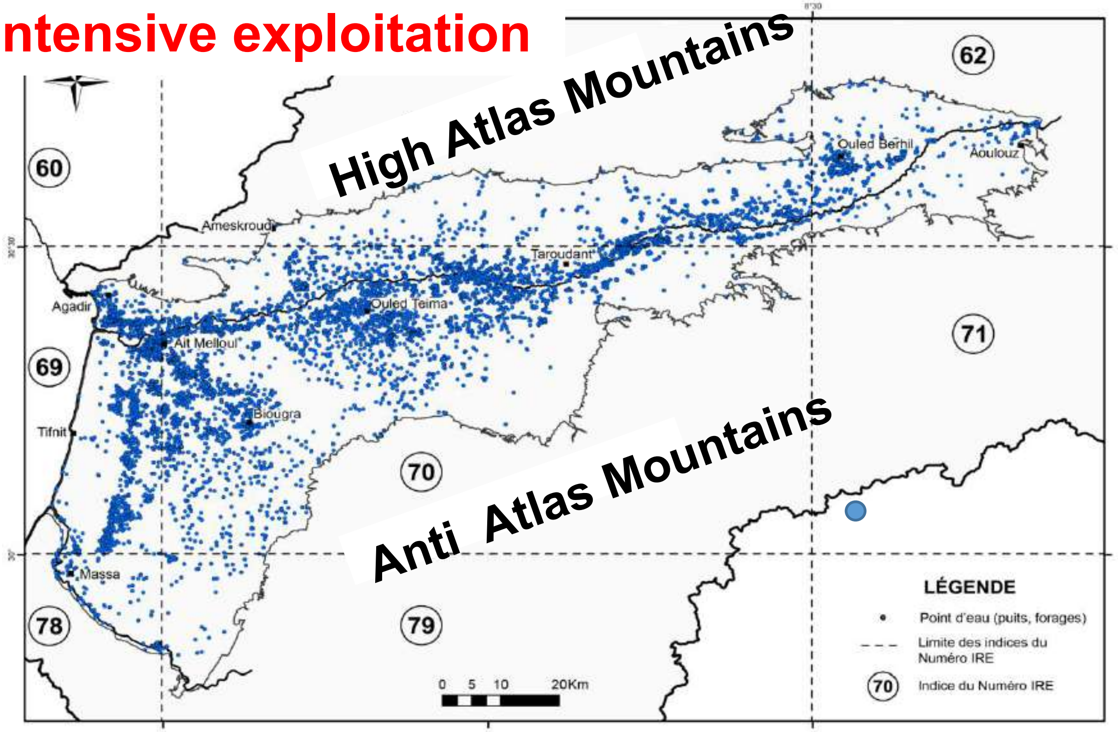
- Case of Souss-Massa region (one of the main economic poles in Morocco)

Land Use in Souss-Massa



- High agricultural activities
- More than 90% of Water resources for irrigation

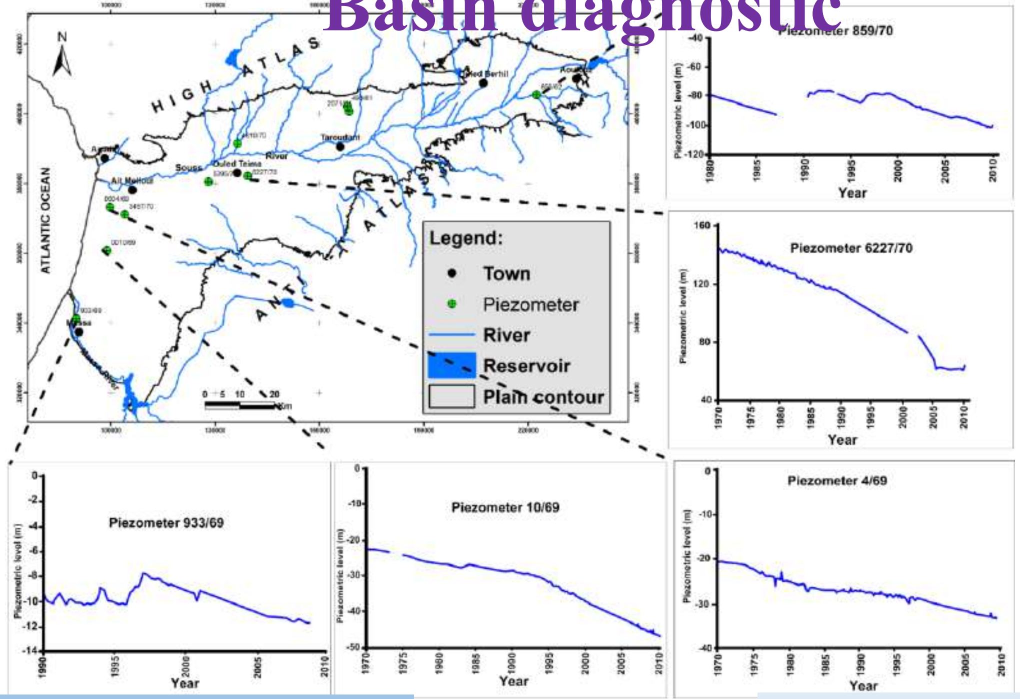
an Intensive exploitation



Source : ABHSMD

More than 25,000 wells and boreholes in Souss-Massa aquifer

Basin diagnostic

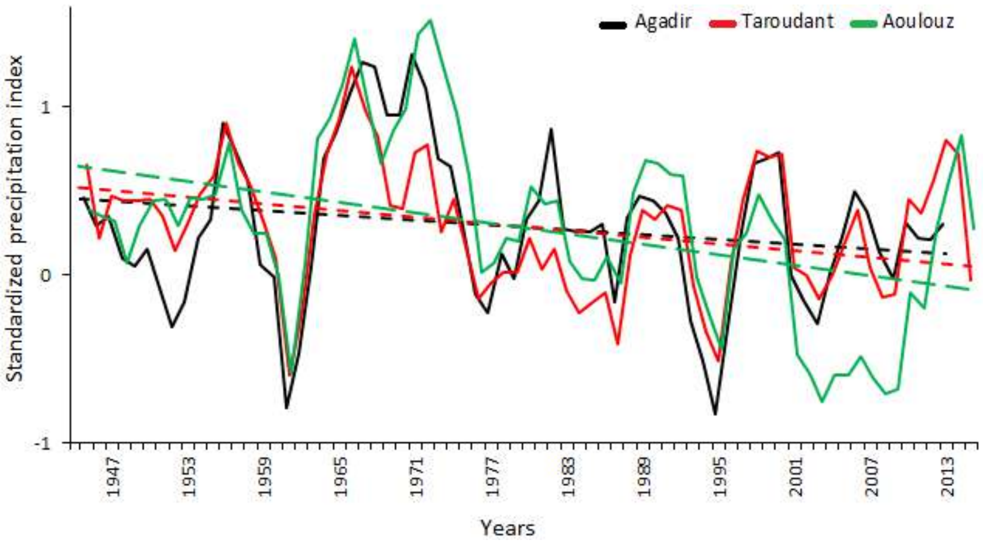


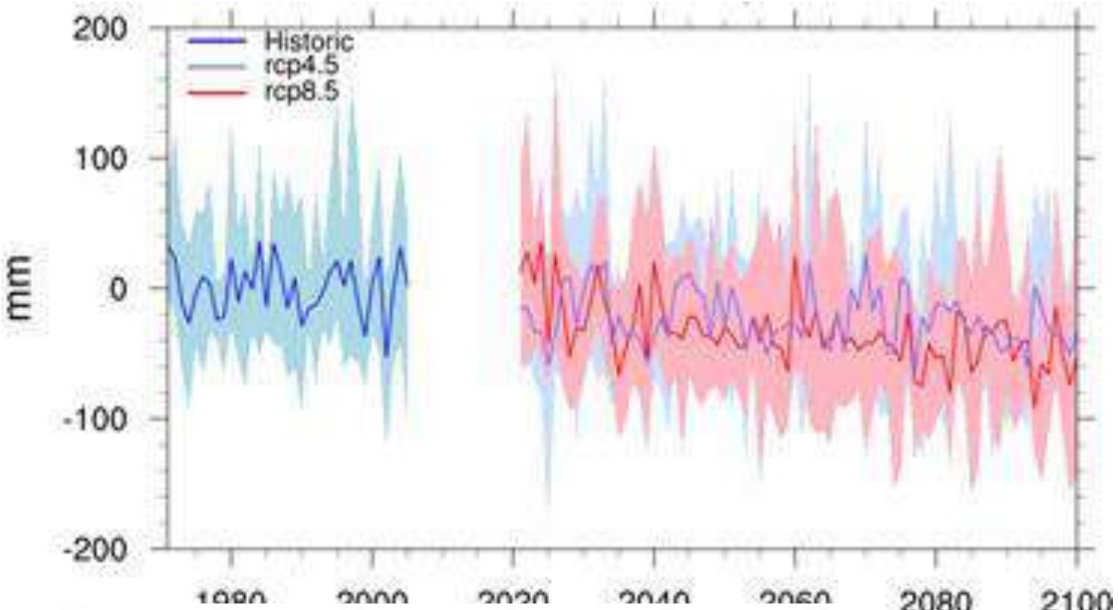
Groundwater resources		Surface water resources
	Natural supply	
425 Mm³	1093 Mm³	668 Mm³
	Water withdrawal	
696 Mm³	1121 Mm³	425 Mm³
	Water use	
Potable and industrial water 7%		Agriculture 93%

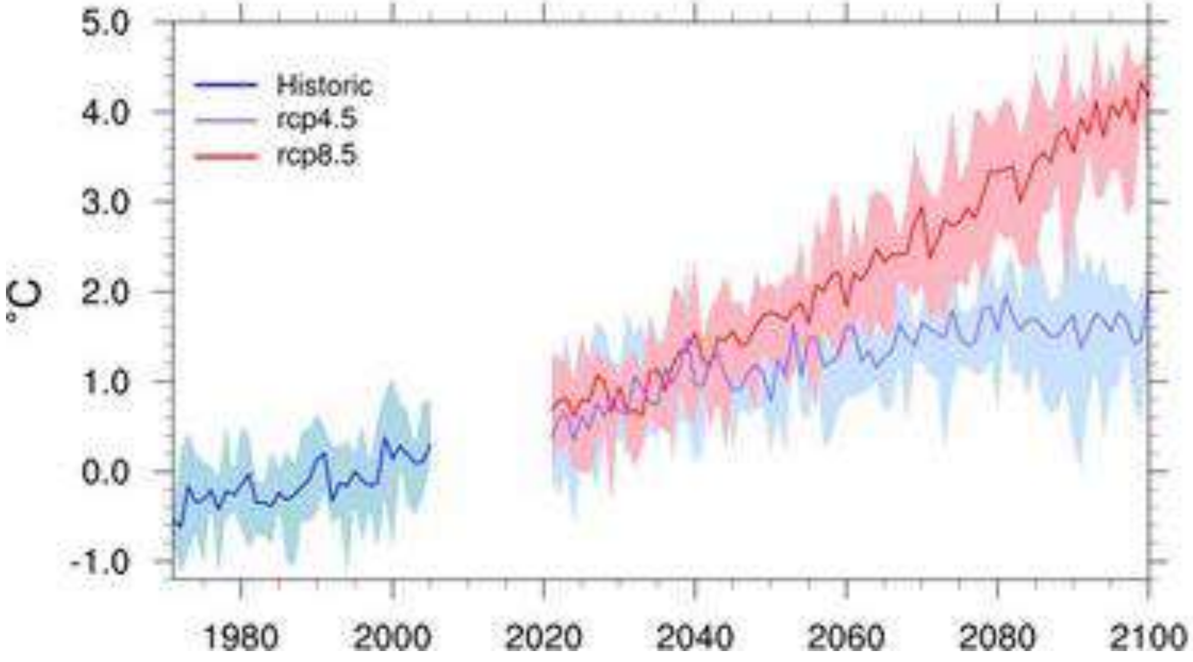
Pumping exceeds Recharge of 271 Mm³.

Deficit: 271 Mm³

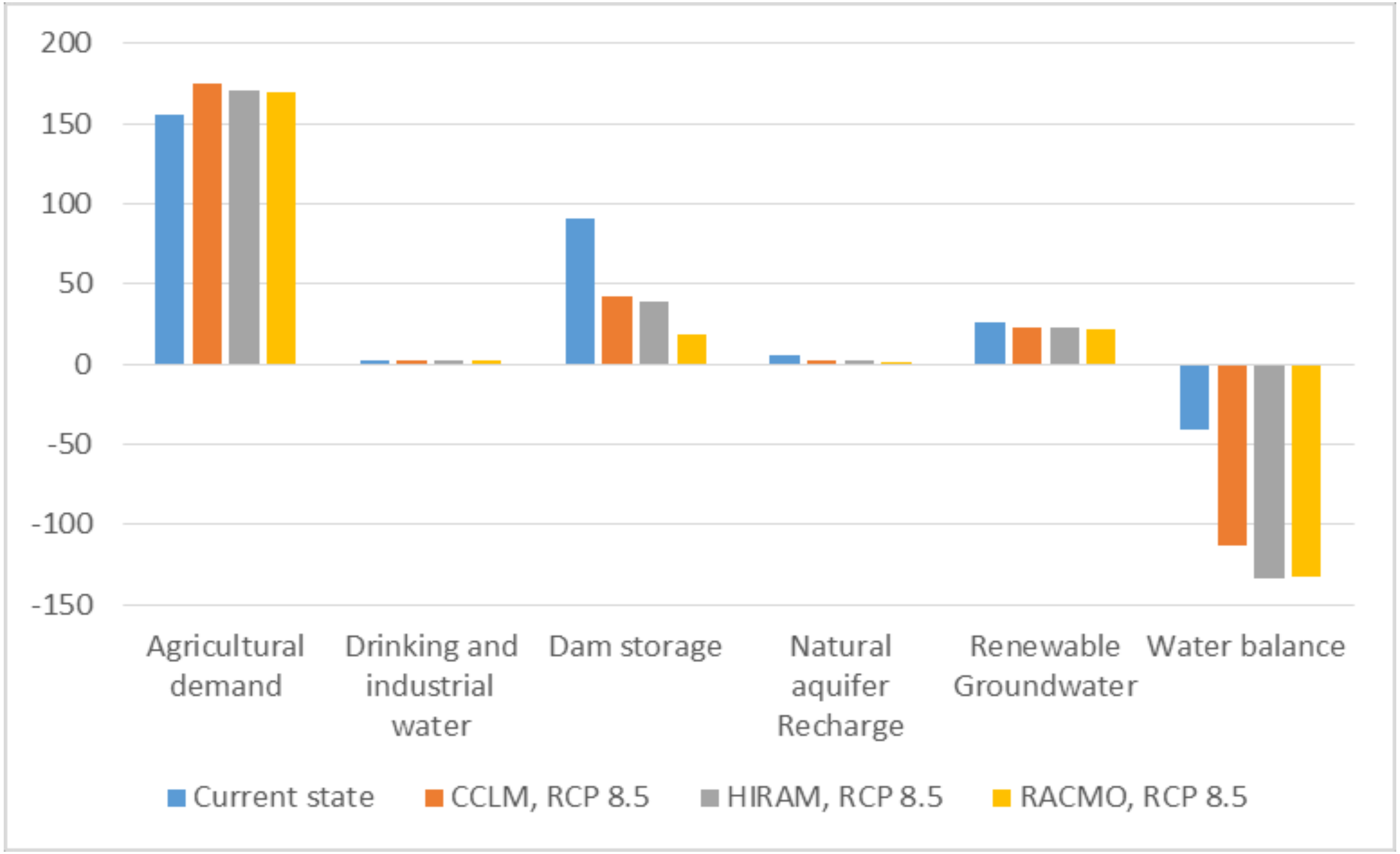
0.5 to 2 m/y during the last 30 years







*tendency of average CORDEX (*Coordinated Regional Climate Downscaling Experiment) *models under RCP 4.5 and RCP 8.5 emission (Representative concentration pathway) scenarios in Souss-Massa (Seif ennasr et al., 2016, STOTEN)*



Climate change impacts on water resources in the Souss-Massa basin during 2030-2050 (Mm^3)

Socio-economic impacts of the overexploitation of groundwater

Revenues and employment

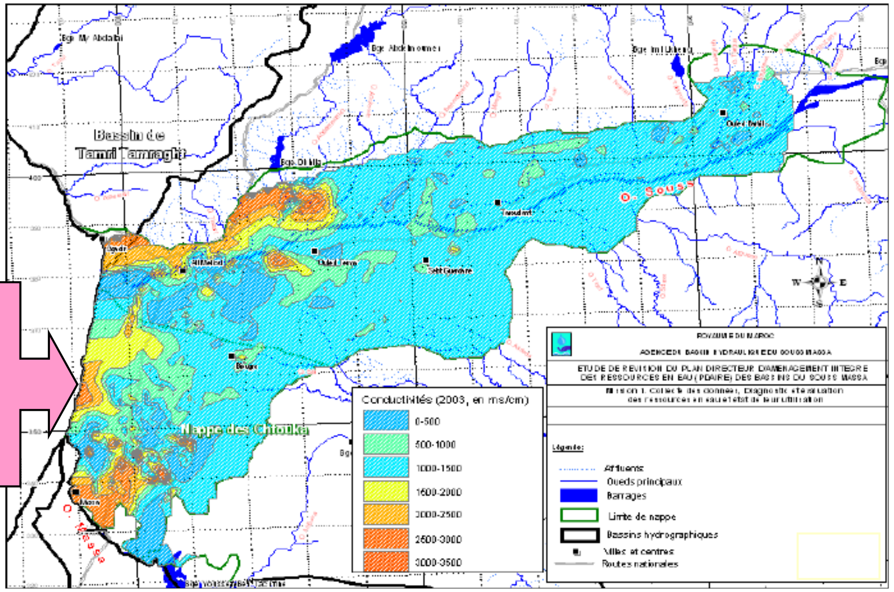
Scenarios	Pumping overcost (Mdhs)	Abandoned irrigated lands		Equivalent employment losses
		Number	Hectares	
"Business as usual"	340	1590	20790	7 930
Conversion to micro irrigation	273	1340	12520	6 680
Safeguard scenario	114	1050	10230	5 255

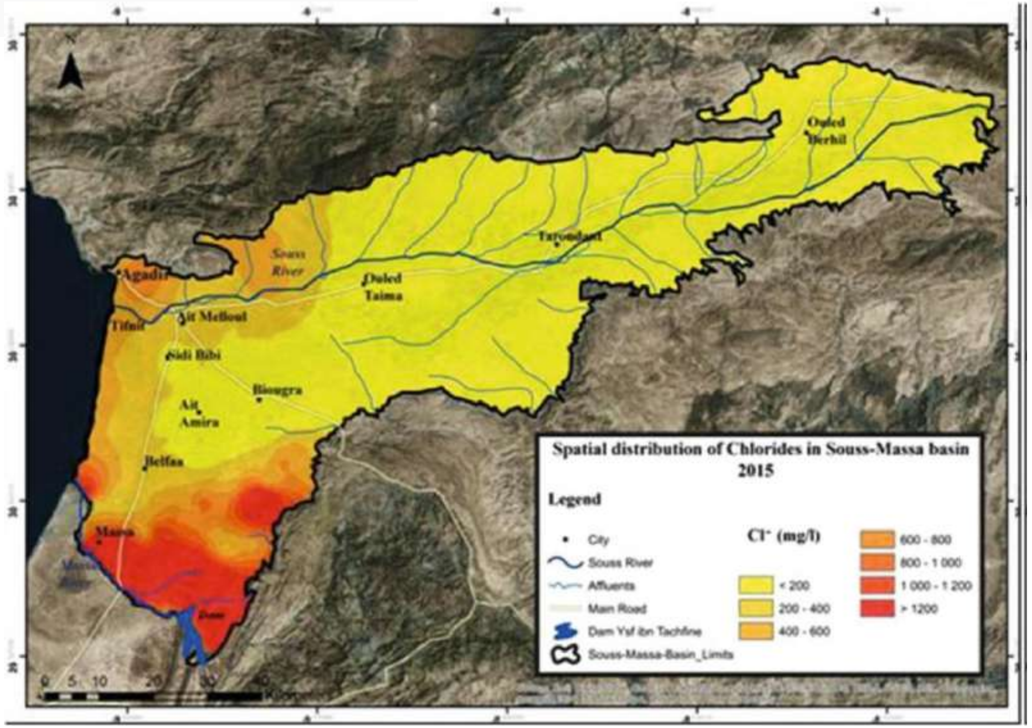
Displacement of agricultural activities

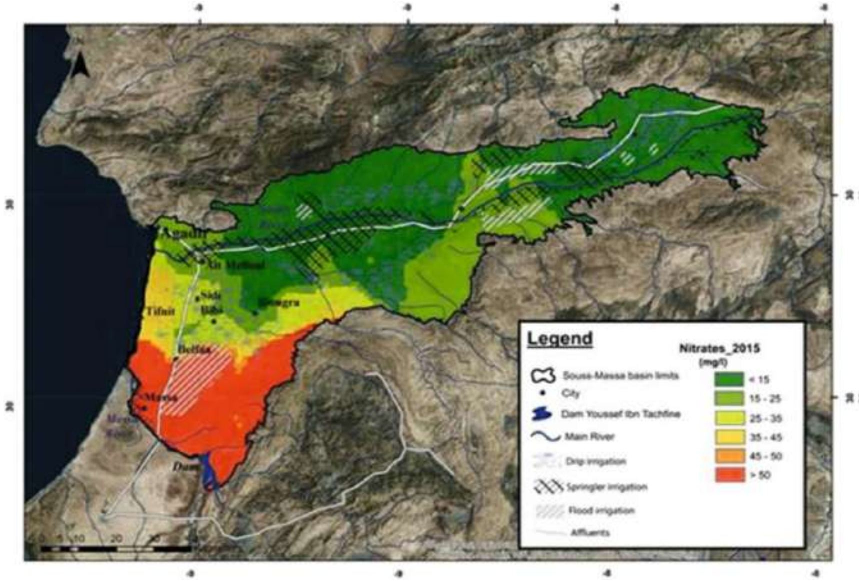
- Toward other area within Souss-Massa basin
- Towards other basins

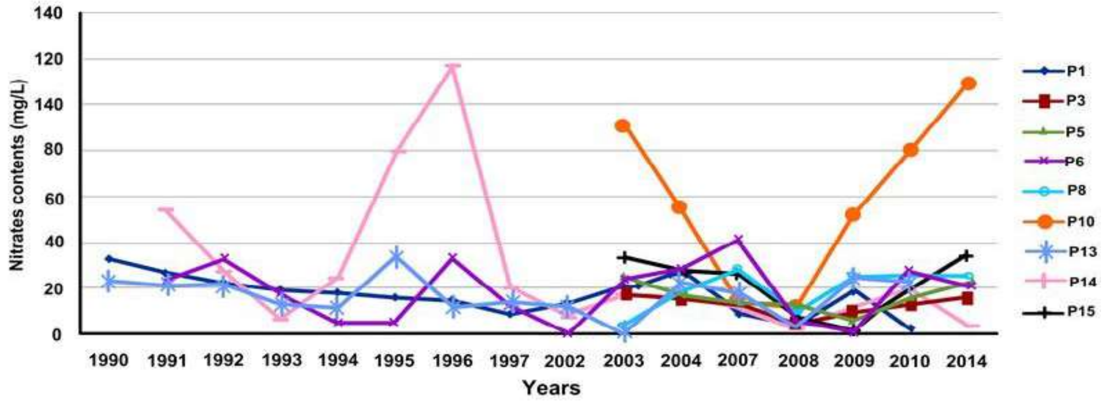
Groudwater quality degradation

Seawater Intrusion risks









Possible strategies

Framework Convention for Safeguarding and Development of WR in Souss Massa Basin

WATER RESOURCE SAFEGUARD STRATEGY

IMPLEMENTATION STUDY OF WATER USERS IN THE PARTICIPATORY MANAGEMENT OF WATER RESOURCES

- *Establishment of a participatory policy for the protection of groundwater for sustainable development;*
- *A plan of action: provisions foreseen for protection and preservation of water resources*
- *Accompany and assist the groundwater commission*

CREATION OF THE AQUIFER COMMITTEE

Topics :

- **Drilling of wells and work planning**
- **Water saving & facilitation of proceedings**
- **Control of irrigated areas**
- **Awareness and communication**

DEVELOPMENT AND RATIFICATION OF THE FRAMEWORK CONVENTION

Axis 1: Economy and valorization of irrigation water

> Theme 1: Conversion of 50,000 ha in localized irrigation (drip)

> Theme 2: Valorization of irrigation water and choice of less demanding crops in water

> Theme 3: Water control and police activities

> Theme 4: characterization of farms

Axis 2: Scientific research

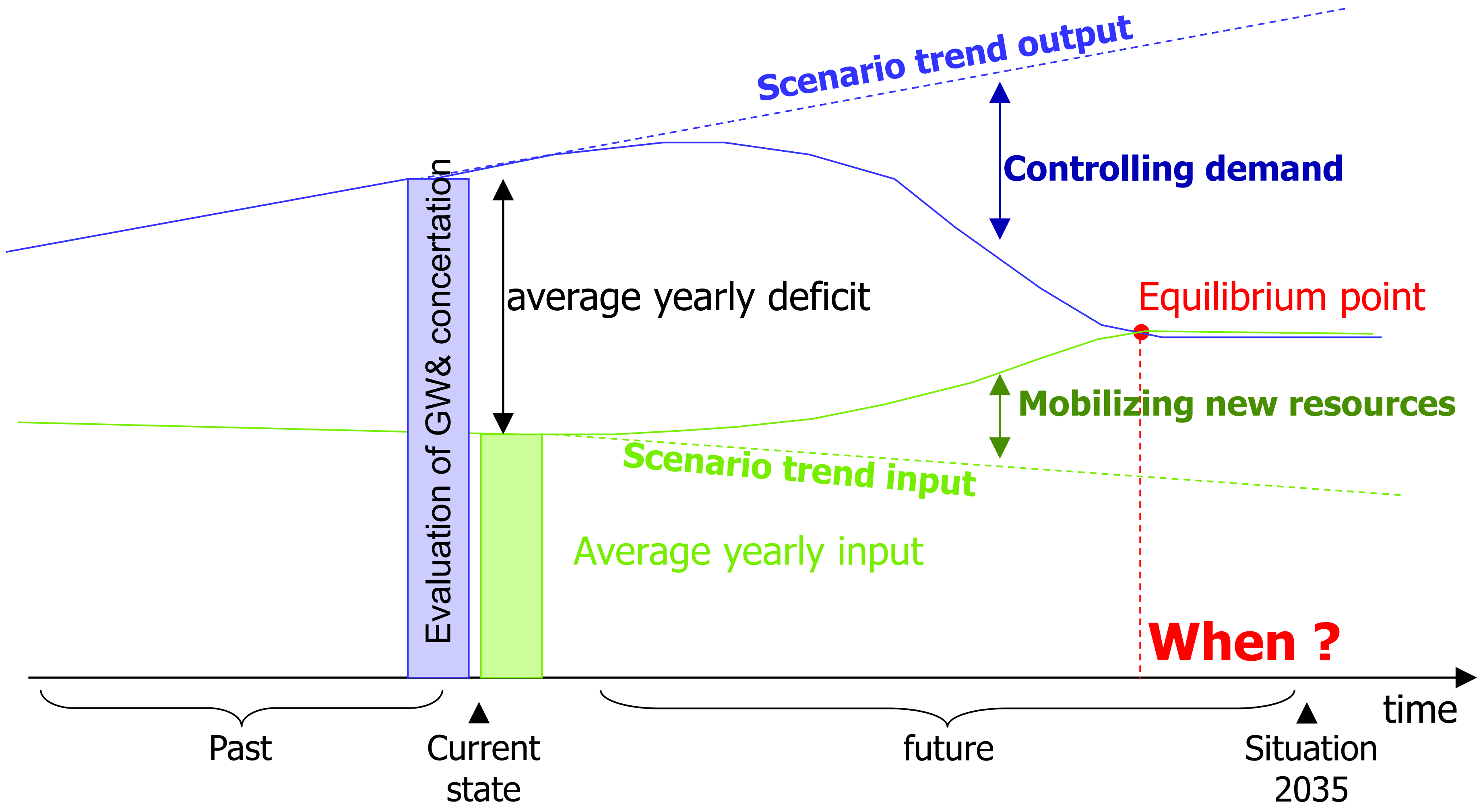
Axis 3: Development and mobilization of groundwater

Axis 4: Mobilization of surface water

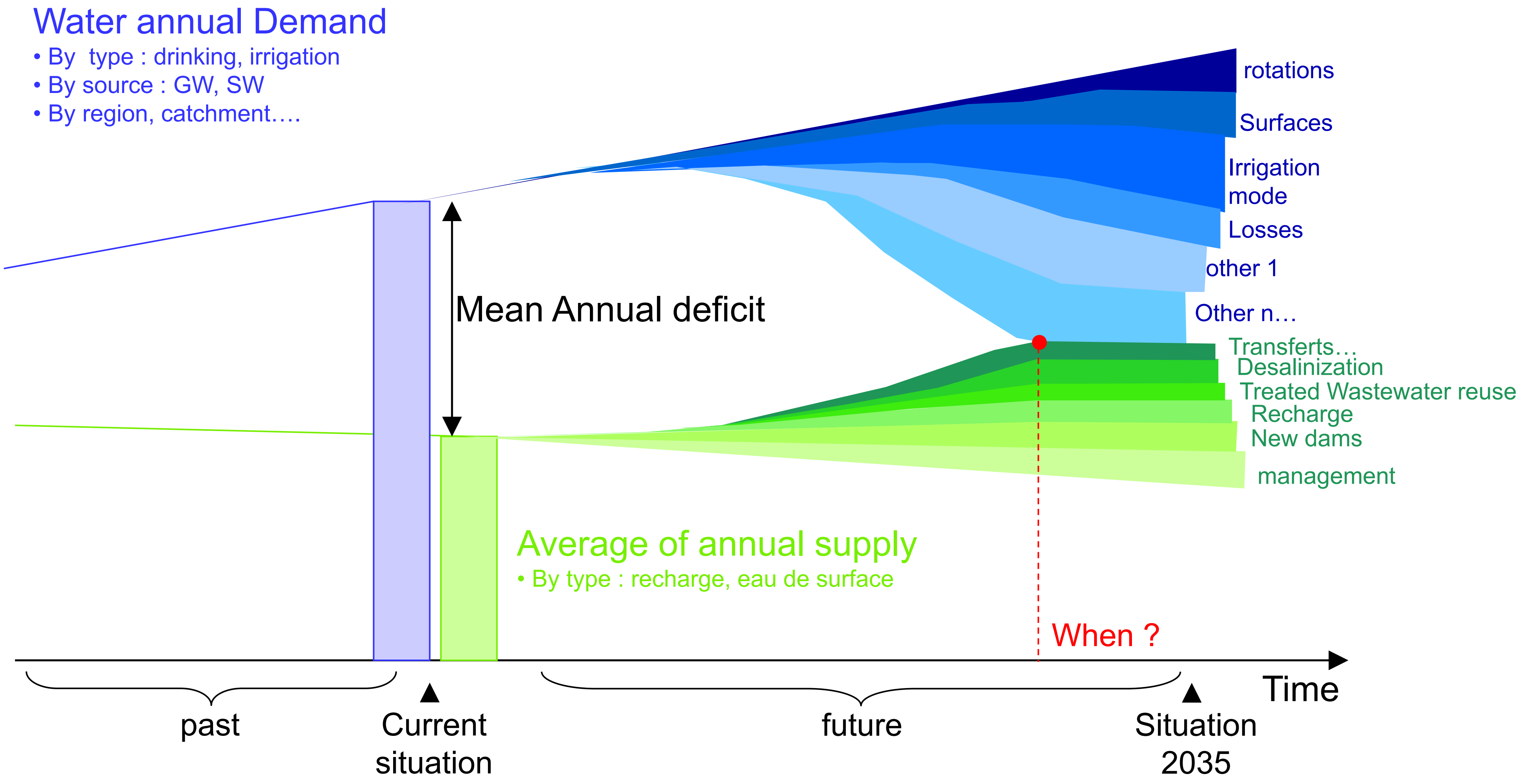
Possible strategies

Objective of the new governance schemes

The necessity to reach a new balance Demand/supply



Using different solutions ...



Model in Souss-Massa basin

GLOBAQUA

Stressors

Abiotic
- Climate change
- Low temperature: frost
- High temperature: Chergui
- Flood

Biotic
- Pests
- Plant diseases
- Locust invasion
- Weed

Anthropic
- Agricultural intensification
- Pollution
- Groundwater overexploitation

Receptors

Agro-ecosystem
- Soil
- Crops
- Fauna: insects
- Livelihood

Forest ecosystem
- Argan tree
- Soil
- Livelihood

Aquifer
- Water quality
- Water quantity
- Livelihood

Wildlife ecosystem
- National park of Souss Massa
- Biodiversity
- Rare species

Wetlands ecosystem
- Birds
- Biodiversity
- Fish

Implications

Groundwater
- Water table lowering
- Nitrate pollution
- Sea water intrusion
- Groundwater salinization
- Spring flow reduction

Biodiversity
- Endemic species threat
- Soil degradation
- Habitat degradation

Human well-being
- Farmer income
- Water access
- Migration
- Employment

Management

Irrigation management
- Conversion to drip irrigation
- Water extraction control
- Use of climate data in irrigation

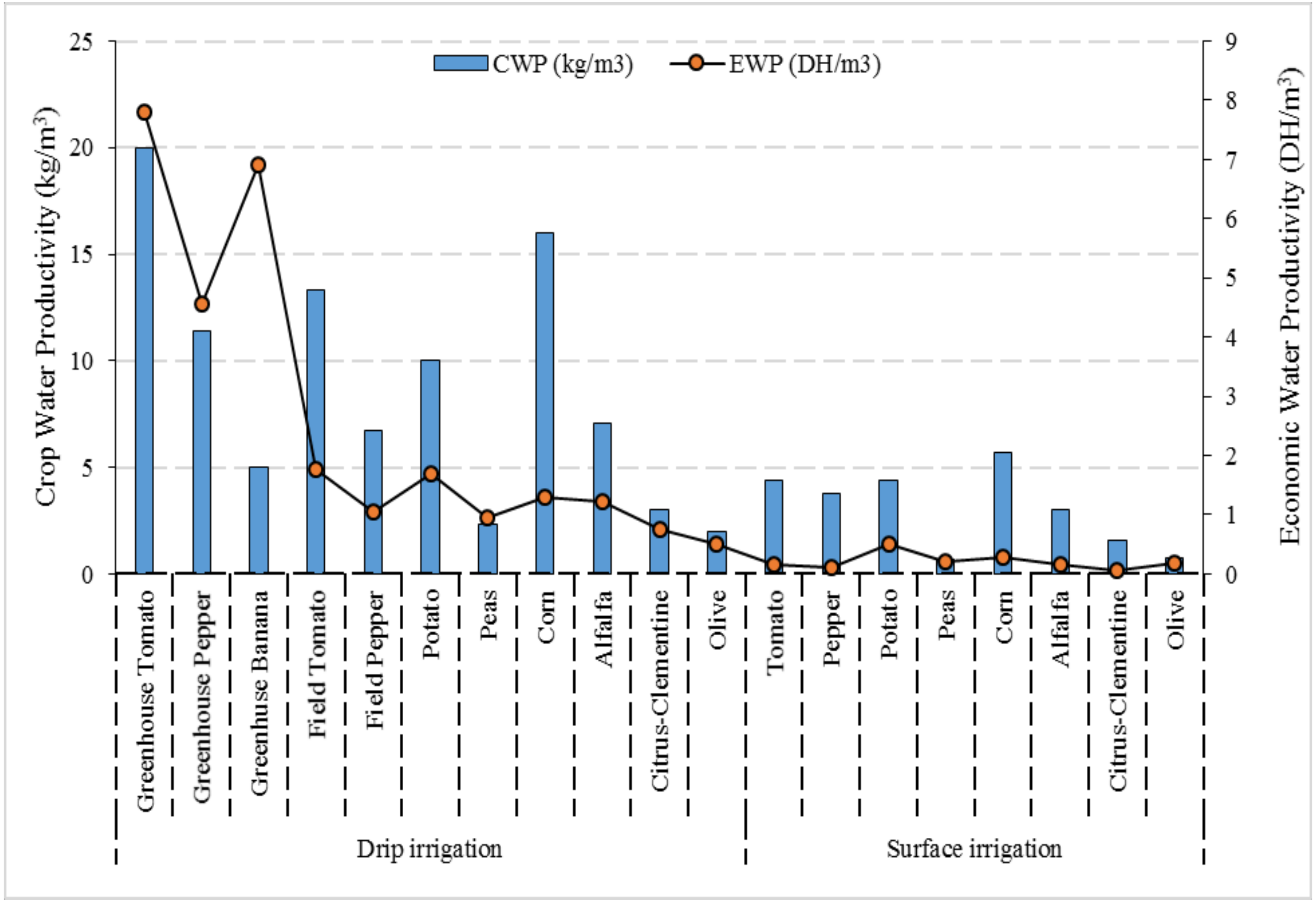
Aquifer contract
- Regulation on wells
- Quota-based system

Ecology
- Argan forest preservation
- Desertification fighting
- Rare species preservation

Agricultural practices
- Cropping system adaptation
- Soilless system

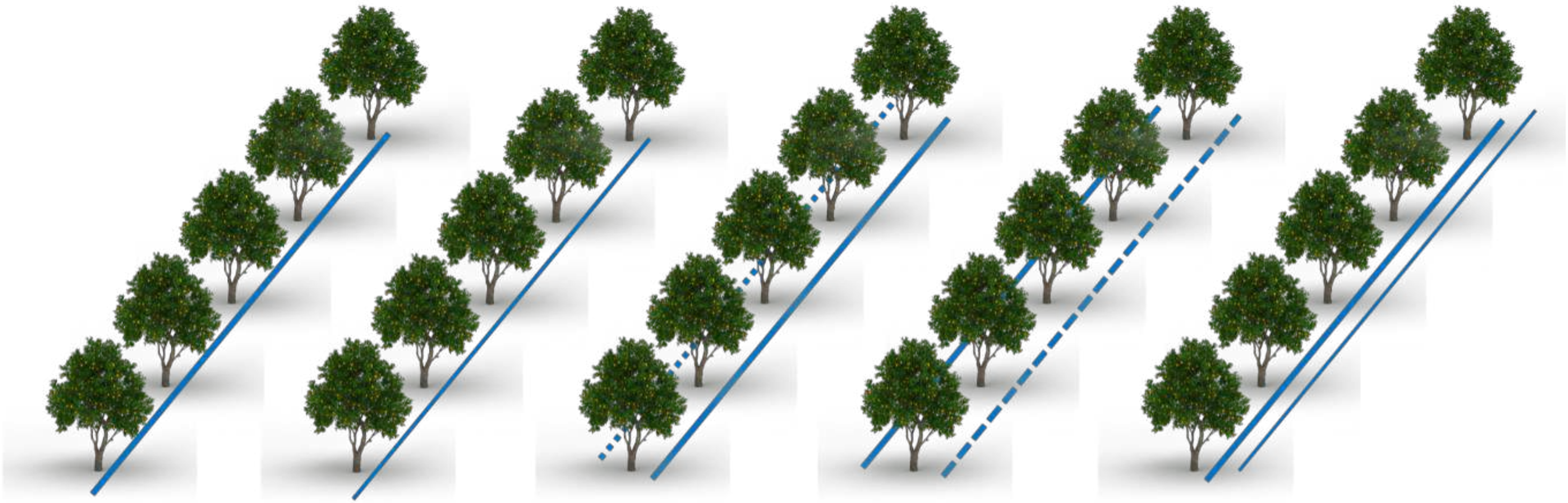
Alternative water resources
- Treated wastewater reuse
- Desalination for irrigation

ECONOMIC AND CROP WATER PRODUCTIVITY OF IRRIGATION WATER



Economic and crop water productivity for the main crops cultivated in the region under two types of irrigation systems (drip and surface irrigation) in Souss-Massa region (Elame et al. 2016)

Experimental layout in the orchard (WASA project)



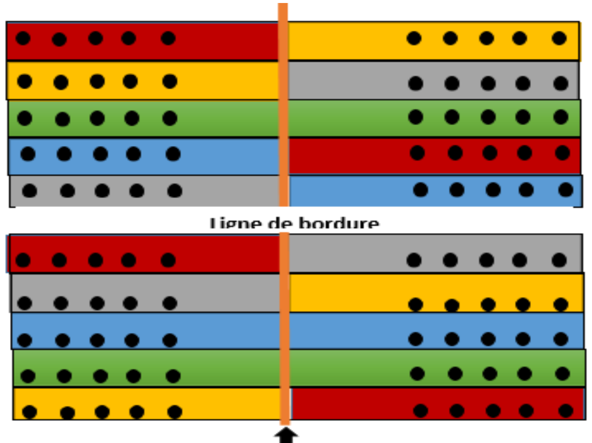
FI-100: Full irrigation based on soil moisture monitoring
Dripper flow: 4 l/hr

DI-75: Deficit irrigation applying 75% of full irrigation
Dripper flow: 3 l/hr

PRD3: Partial Root-zone drying with 3 days frequency
Dripper flow: 4 l/hr
2 irrigation lines: 1 ON and 1 OFF

PRD3: Partial Root-zone drying with 7 days frequency
Dripper flow: 4 l/hr
2 irrigation lines: 1 ON and 1 OFF

RDI: Regulated Deficit irrigation applying 50% during vegetative growth stage
Dripper flow: 4 l/hr and 2 l/hr
2 irrigation lines: 2 l/hr ON during vegetative growth stage and 4 l/ha ON during the remaining crop stages



The experimental layout of the trial (the treatments are in color and the trees are represented by the black dots). An identical layout is used for the two varieties

Bouchaou et al., 2017

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The Souss-Massa River Basin, Morocco

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