Adaptation of Irrigated agriculture to Climate change –
AICHA-ATCHA Workshop. 14th-19th November 2016
at IISc Civil Engineering Department – Bangalore

AICHA Model
Coupling in RECORD

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Objectives

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Develop an integrated model of agronomy, hydrogeology and economics for assessing the sustainability of agricultural systems in the context of climatic change

WP2: AICHA 1D: **Coupling crop model, hydrogeological model and economic model for assessing scenarios of climate change at the farm scale.**

Task 2.1: calibrating STICS

Task 2.2: implementation of the coupled model: AICHA 1D

Task 2.3: Farm level scenarios

WP3: AICHA 2D: Impact of spatial interactions on the sustainability of farming systems under CC at the watershed scale

Task 3.1: Distribution of soil properties in the Berambadi watershed

Task 3.2: Land use change, crop variables and soil moisture from remote sensing

Task 3.2: AICHA 2D: Distributed version of the model

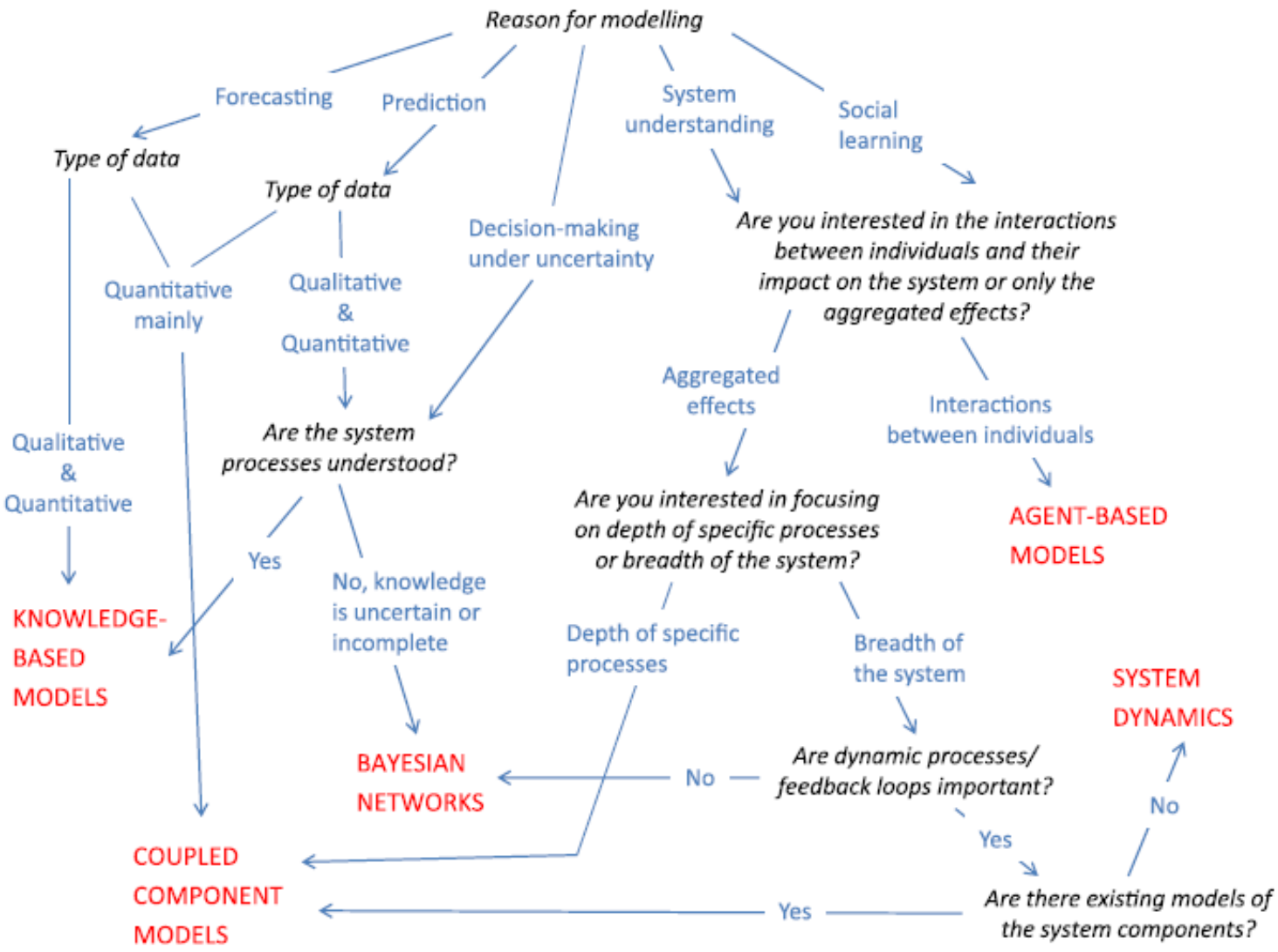
WP4: Farmer decision model to study the adaptation of farming systems to climate, groundwater and economic scenarios

Task 4.1: Implementing decision model

Modelling approach

Decision tree for selecting the most appropriate integrated modelling approach

(« Selecting among five common modelling approaches for integrated environmental assessment and management, Kerry et al. EMSS 2013)



Coupling models on RECORD platform

- **Coupling models**: a functionnality of the RECORD platform

- **Coupling requires**:
  - **Having the models as standalone components on the platform**.
    How?
    - By software wrapping of legacy code (STICS in Fortran, AMBHAS in Python)
    - By developping them from scratch (Namaste is based on the Decision framework provided by the platform)

  - **To have specified the type of interactions** between the components (feedbacks, synchronization, …)

  - To take into account:
    - **different time scales**
    - **different spatial scales**

Model(s) available

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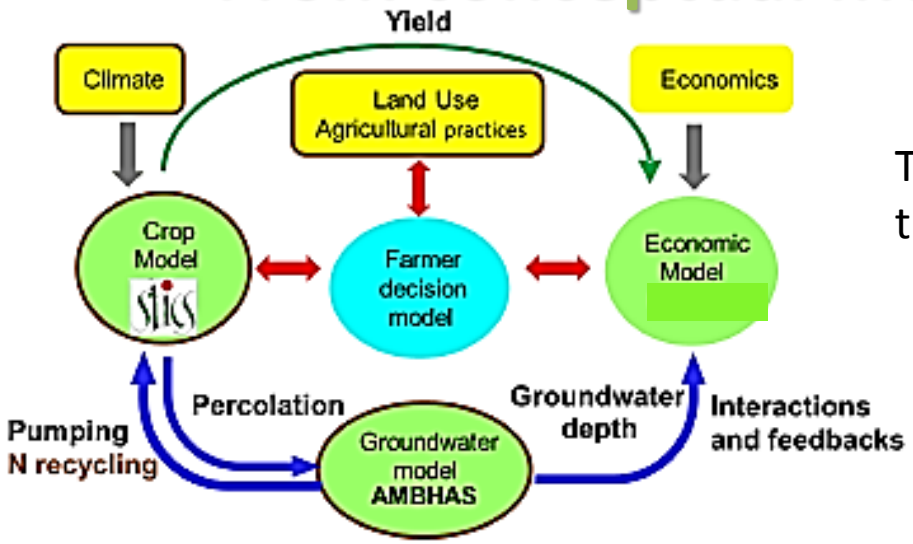
Components

	Groundwater	Biophysical	Management
Wrapped code			Economic Model
New code	Pump model Nitrogen Model		Farm Model (Namaste)

From conceptual model to simulators



The model pattern in the context of the AICHA project.

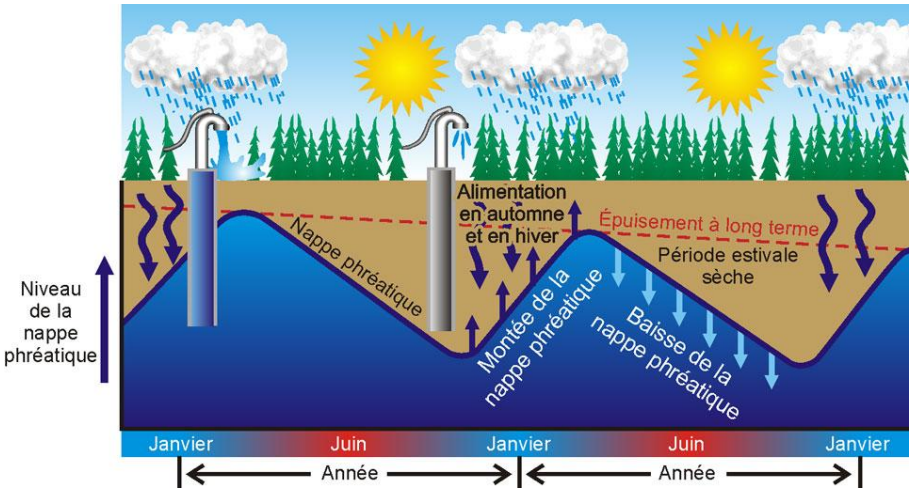
Berambadi: 84 km2

STICS → Plot
AMBHAS → Grid 100m*100m (150 x 250)
Farm model → group of plots

Timestep → daily to year
Duration → one year to several years

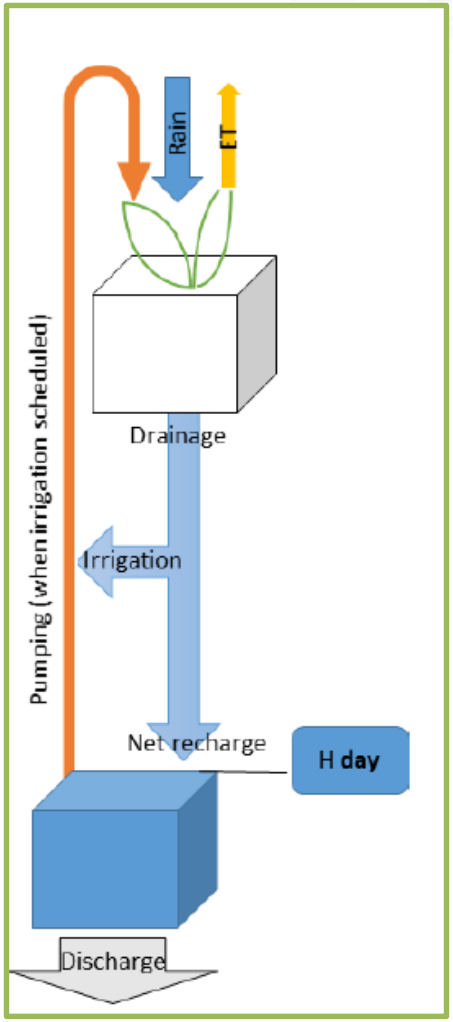
1D model: Coupling crop model, hydrogeological model

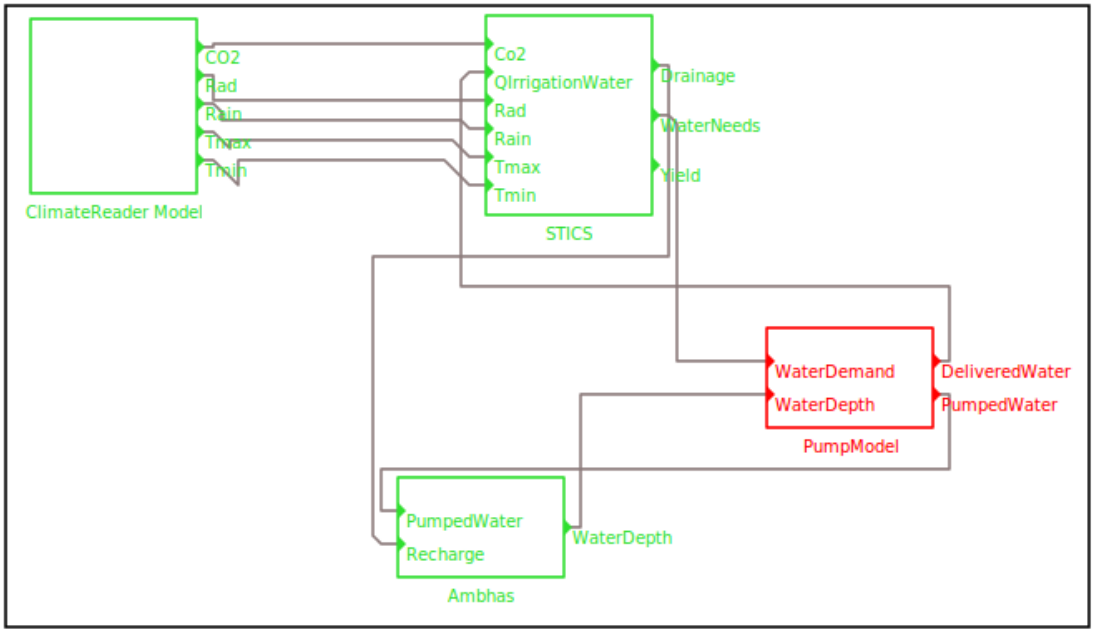
- **Objectives**:
  - To study the interactions of agriculture (i.e crop rotations and management) and groundwater.
  - To study the nitrogen concentrations in groundwater
  - Application to some specific locations (monitored plots and borewells):
    - validation of the model
    - impact of climate change



1D Model

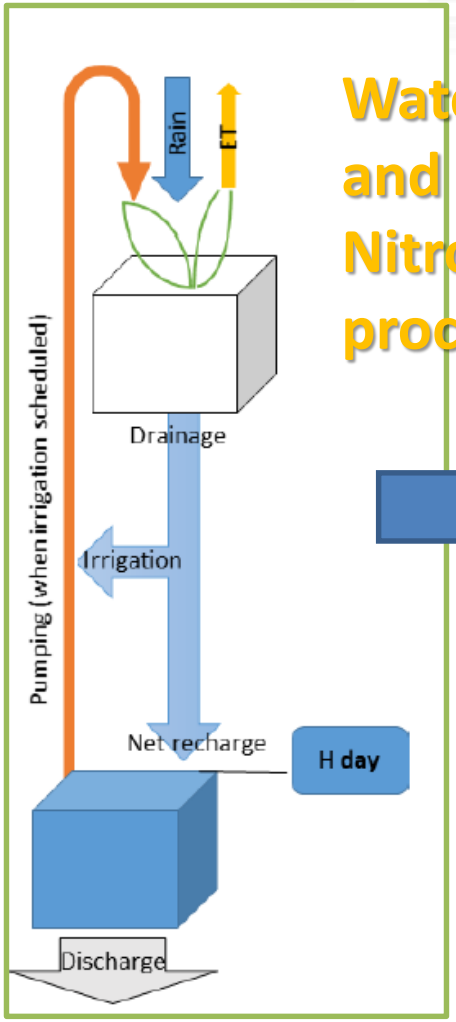
Long term simulations of the interactions between agriculture and groundwater resources (**Master Maud BONZI**, Dr Muddu Sekhar, Dr Laurent Ruiz)



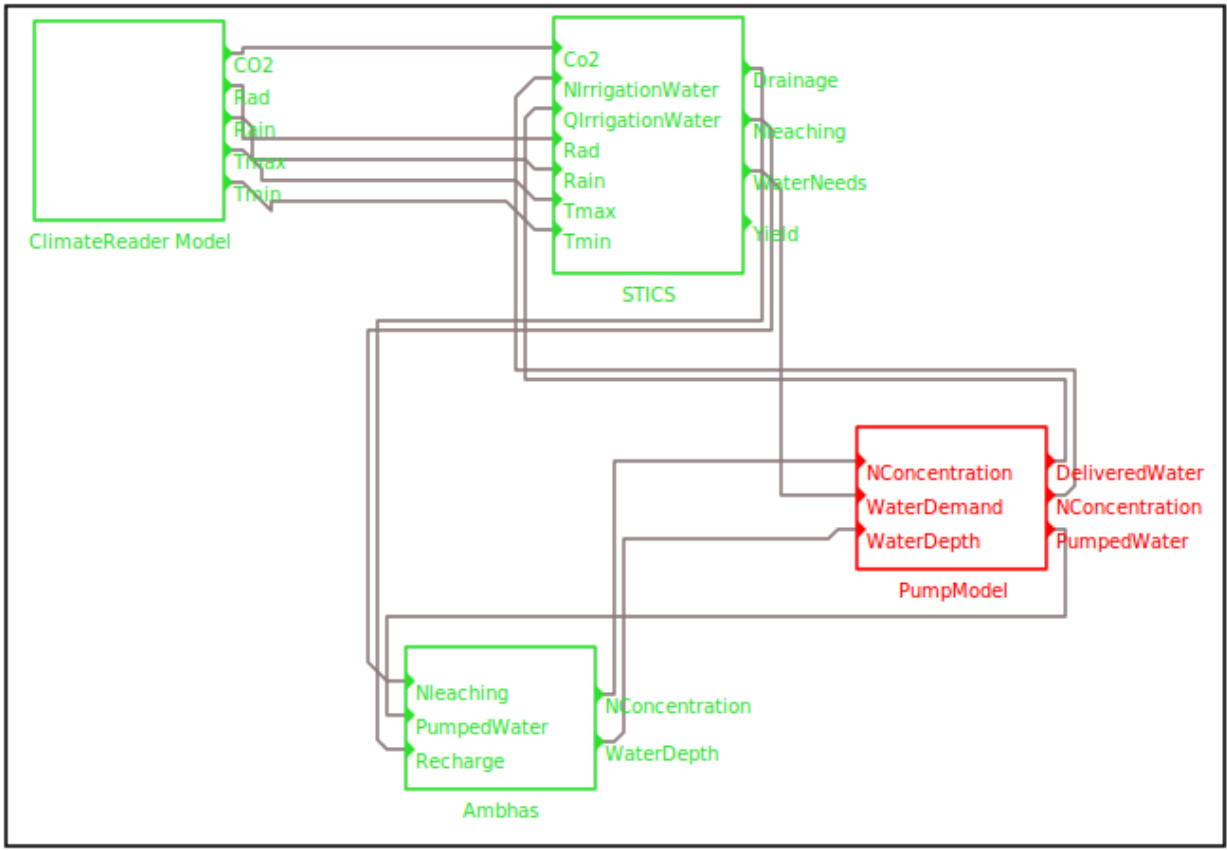


1D Model

Modelling the impact of irrigated agriculture on groundwater resource and quality in semi-arid tropical catchment (**PhD Buvaneshwari S.**, Riotte J, Ruiz L., M.S. Mohan Kumar, Sekhar M.)



Water and Nitrogen processus



EXAMPLE OF RESULTS

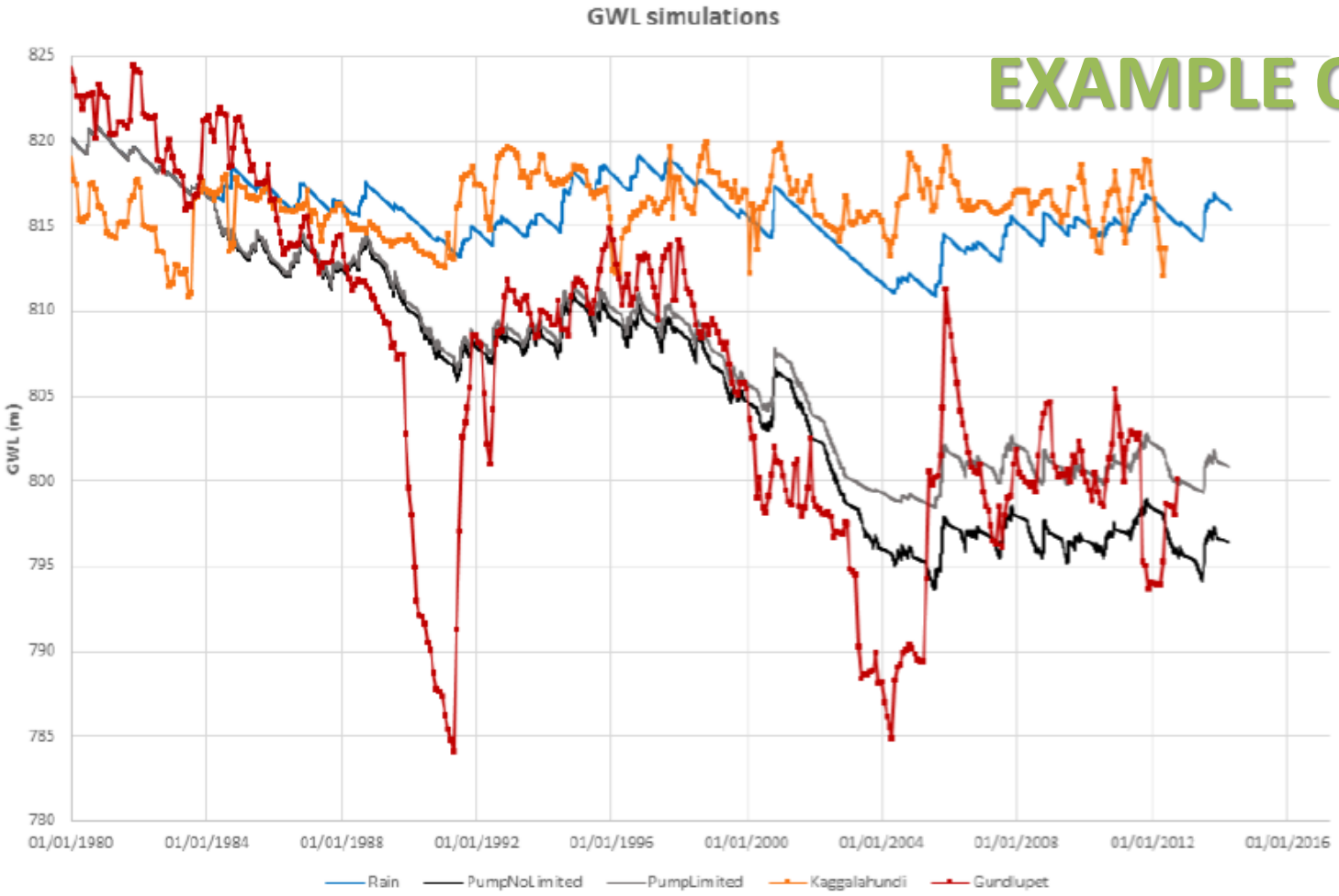
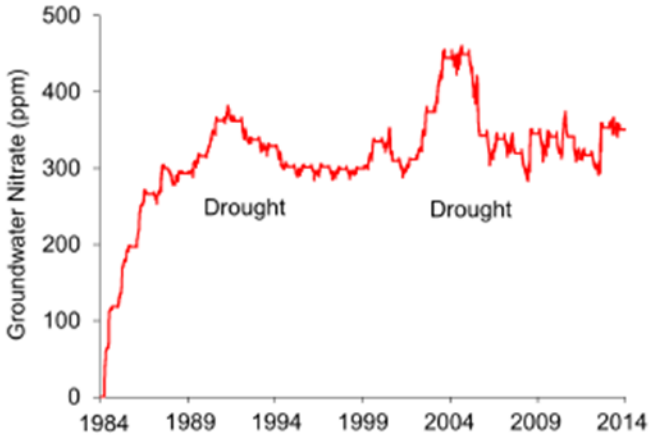


Figure 32 The 3 simulations compared to the observed data



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1D Model: Farm/Village . Namaste

Objectives of the model:

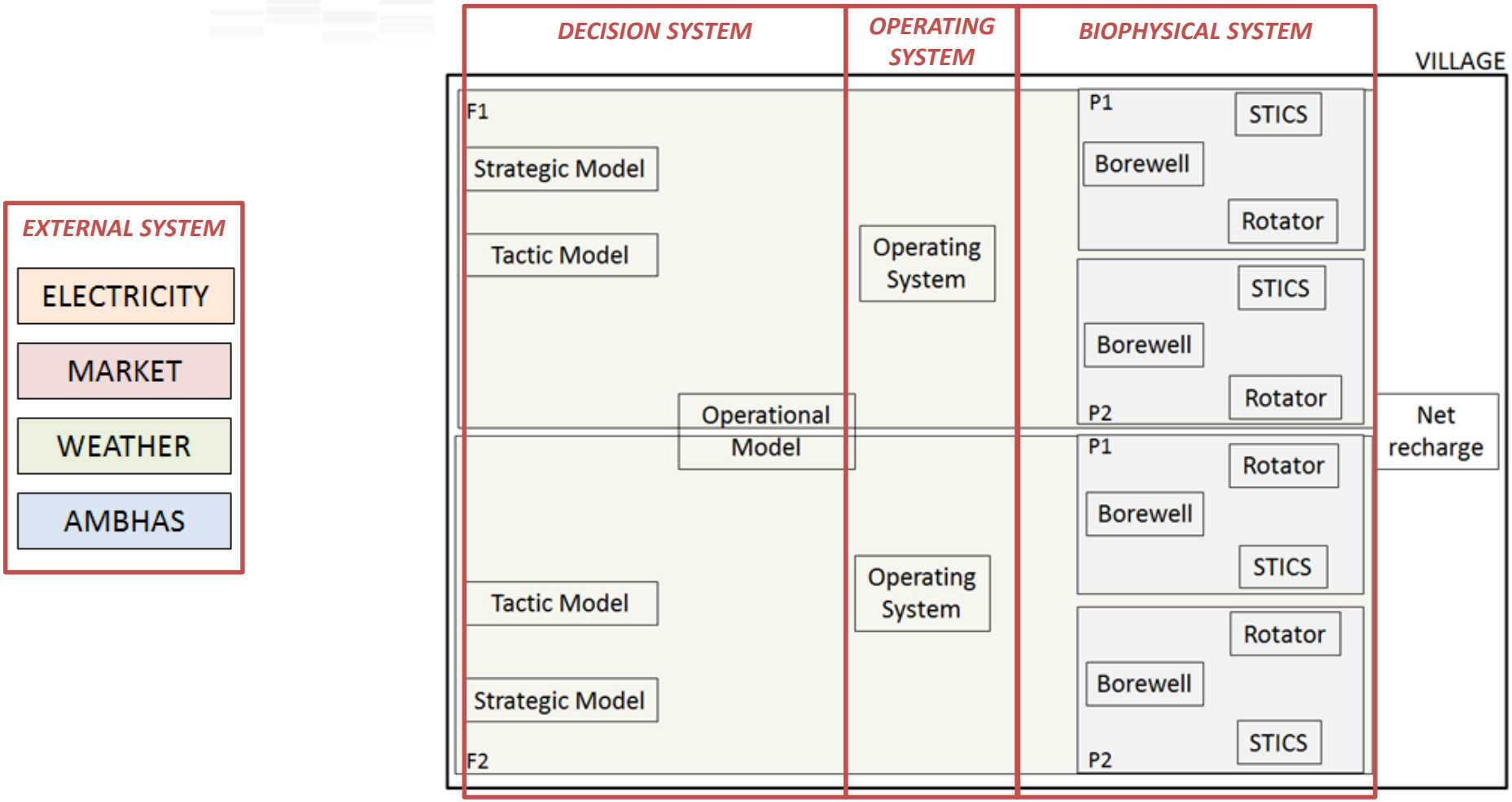
Simulate farmers' adaptations

- to uncertain events (climate change, water table depletion, economical environment, agricultural reforms)
- in limited and shared resource conditions

Namaste simulator:

- 10 years of planning horizon
- virtual village = 2 virtual farms
- village = 110 female labor, 90 male labor, 4 bullocks, 1 tractor
- farmer 1: 1ha / 1 bullock / no tractor / farmer & wife / hire village labor / rent village equipment
- farmer 2: 2ha / 2 bullocks / no tractor / farmer & wife / hire village labor / rent village equipment
- 1 AMBHAS cell

1D Model: Farm/Village . The structure of the simulator



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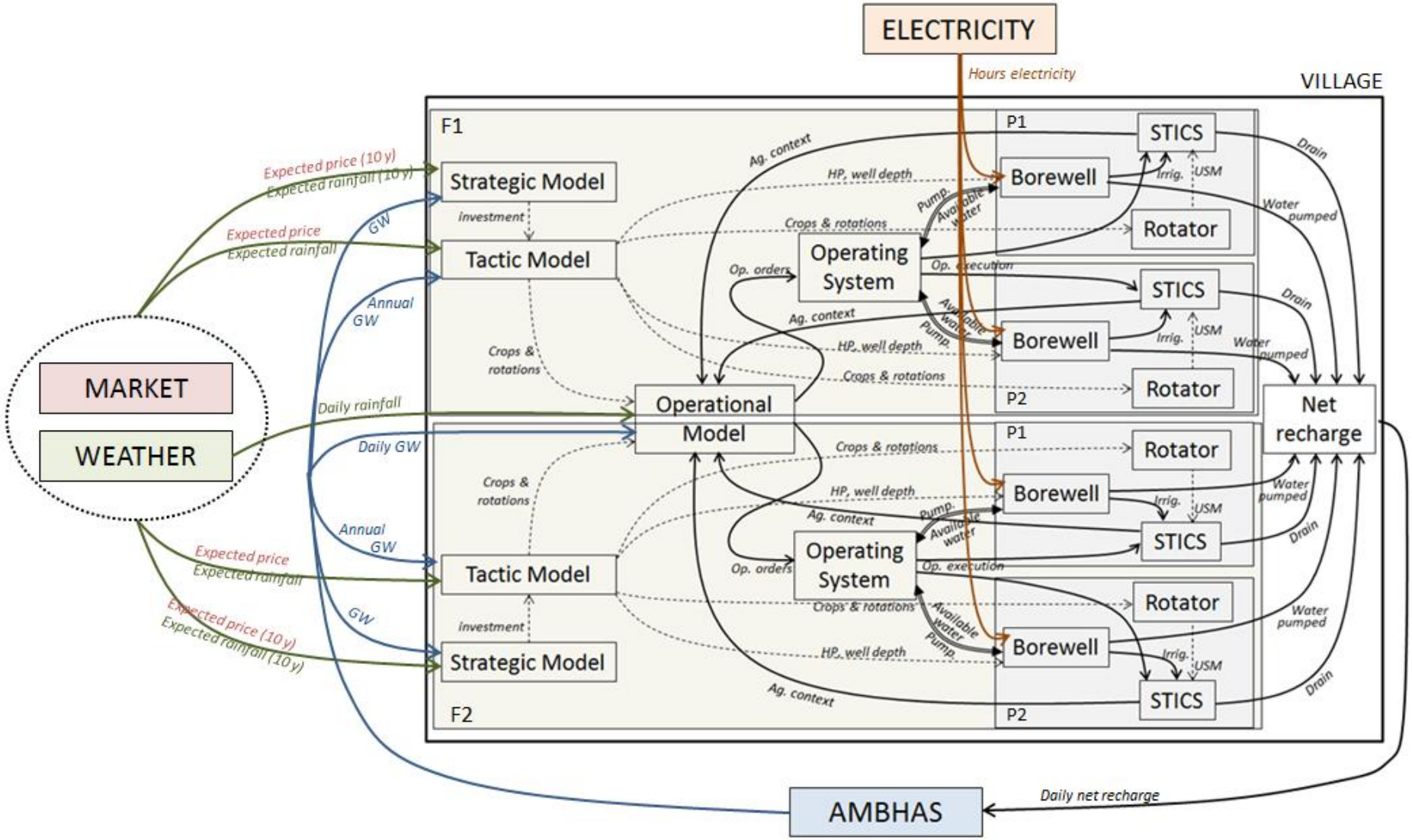

« Serious game »

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Crop map generator

Choose grid file

9 x 10

- [ ] Use zones limits
- [x] Add grid
- [x] Add IDs

Generate crop allocation

Nombre d'identifiants uniques

6

% de type 1

20

% de type 2

15

% de type 3

40

% de type 4

5

% de type 5

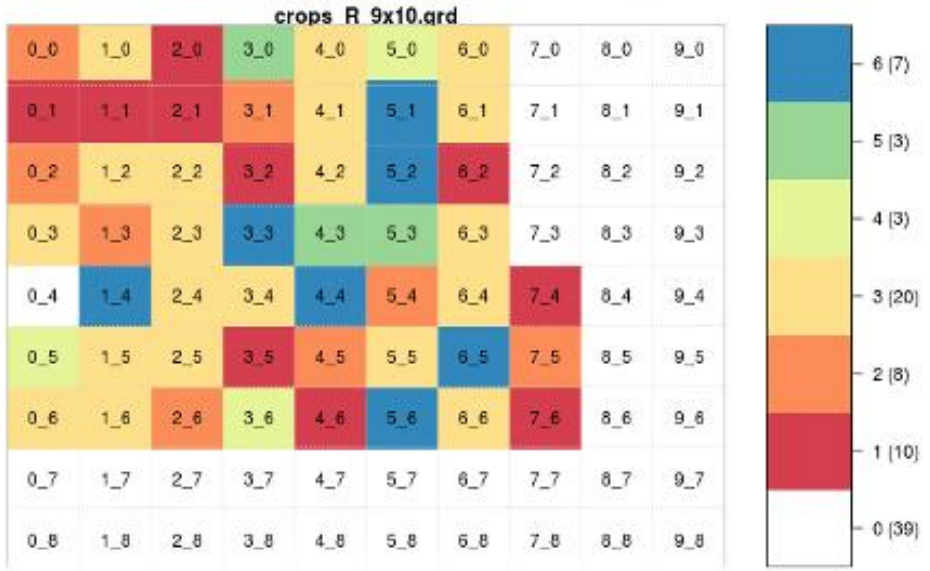
5

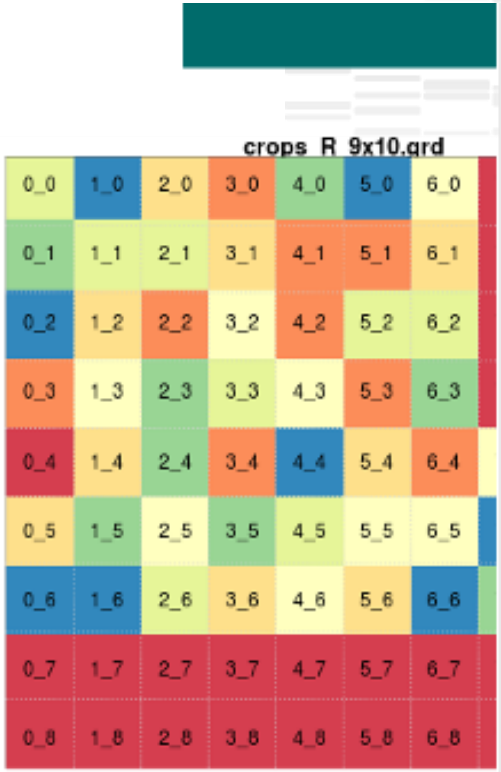
% de type 6

15

sum% : 100

Maps | Watershed limits | Zones limits | Crop Allocation





Stics

Choose grid file

CropAllocator

Simulation duration:

100

Ambhas GroundWater model parameters editor

Plot parameters editor

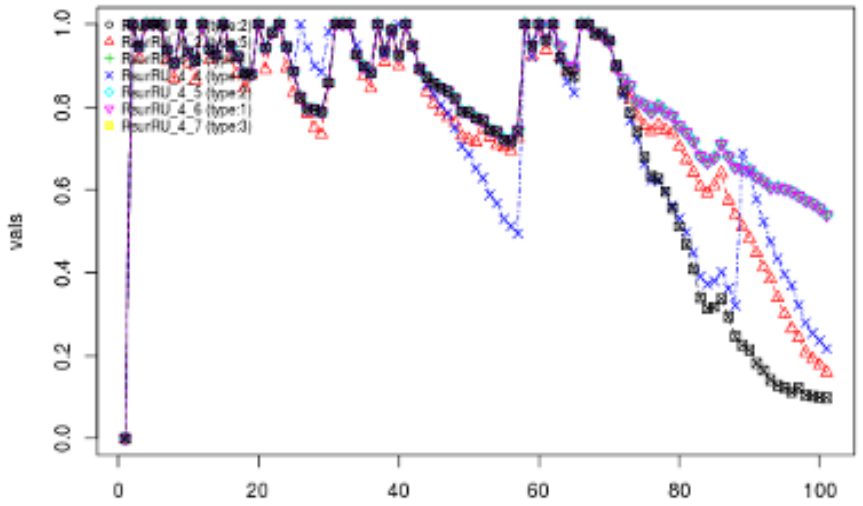
Variable to plot

- GroundWater level
- RsurRU
- airg(n)
- codebbch
- drain
- lai(n)
- masec(n)

Select Y variable(s):

RsurRU_3_5 (type:1)
RsurRU_3_6 (type:5)
RsurRU_4_1 (type:2)
RsurRU_4_2 (type:5)
RsurRU_4_3 (type:1)
RsurRU_4_4 (type:6)
RsurRU_4_5 (type:2)
RsurRU_4_6 (type:1)
RsurRU_4_7 (type:3)
RsurRU_5_0 (type:2)

Crop allocation map



Run simulation

Use Case Selection

Choose scenario

Positive Pulse

Choose grid file

9 x 10

Simulation duration:

20

Ambhas GroundWater model parameters editor

Plot parameters editor

Variable to plot

- GroundWater level
- net_recharge

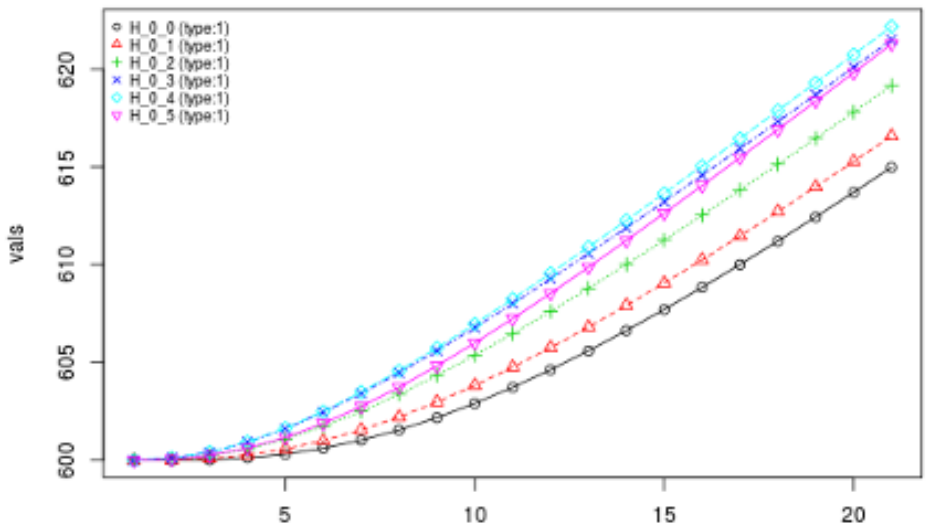
Select Y variable(s):

- H_0_0 (type:1)
- H_0_1 (type:1)
- H_0_2 (type:1)
- H_0_3 (type:1)
- H_0_4 (type:1)
- H_0_5 (type:1)
- H_0_6 (type:1)
- H_1_0 (type:1)
- H_1_1 (type:1)

Simulation results data

Plot (map) | Plot (timeline) | Table | Show vpz | Available Crops info

Crop allocation map



Scientific outputs

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Overview on some ongoing modelling works applied to BERAMBADI watershed

- Plot scale
  - Long term simulations of the interactions between agriculture and groundwater resources (**Master Maud BONZI**, Dr Muddu Sekhar, Dr Laurent Ruiz)
  - Modelling the impact of irrigated agriculture on groundwater resource and quality in semi-arid tropical catchment (**PhD Buvaneshwari S.**, Riotte J, Ruiz L., M.S. Mohan Kumar, Sekhar M.)
- Farm scale
  - A dynamic integrated model for simulating farm practices under groundwater scarcity in semi-arid region of India (**PhD M.Robert**, A.Thomas, J-E.Bergez)
- Territory scale
  - Berambadi scenarios (group Big Survey)

Training session: overview on coupling models on RECORD (India -2013) Summer school (France – 2017)

École-chercheurs

À l'initiative du réseau des utilisateurs de la plateforme RECORD

Approches interdisciplinaires de la modélisation des agroécosystèmes

- ***Système complexe, Modèle, Code***

Du 7 au 10 mars 2017 à Sainte Foy Lès Lyon

Contexte et enjeux

Face aux enjeux actuels en lien notamment avec le changement climatique et l'évolution des systèmes de production, l'étude des agro-écosystèmes nécessite de plus en plus un travail pluridisciplinaire. Le recours à l'analyse systémique, la modélisation et l'expérimentation virtuelle informatique est une démarche qui permet d'analyser et évaluer un grand nombre de possibilités dans une grande diversité de situations.

L'Inra a initié le développement de plateformes de modélisation et de simulation pour aider les scientifiques dans ce travail compréhensif et prospectif. Plus spécifiquement sur l'étude des agroécosystèmes, la plateforme RECORD a été développée.

Cependant ces plateformes semblent encore actuellement méconnues bien qu'elles constituent un formidable outil de partage et de travail pluridisciplinaire.

Les enjeux de cette école-chercheurs sont :

- Permettre aux chercheurs de développer leurs compétences sur l'analyse systémique et la modélisation de systèmes complexes ;
- Elargir la communauté Record actuelle pour avancer sur les questions d'analyse, d'évaluation et de conception d'agro-écosystèmes.

L'école-chercheur vise à donner un panorama de la chaîne : système complexe – modèle – implémentation en code informatique. La plateforme RECORD sera le principal outil mobilisé dans le courant de cette chaîne. ■

Objectifs de l'école

- Appréhender la démarche systémique pour une construction interdisciplinaire de modèles
- Mettre en œuvre la modélisation systémique sur un exemple fil rouge. Il s'agira d'un modèle de gestion territoriale de l'eau avec des enjeux agricoles, sociétaux et environnementaux.
- Développer des bonnes pratiques de modélisation (code, évaluation…)
- Connaître les principales plateformes de modélisation et les situer les unes par rapport aux autres
- Découvrir et s'initier à la plateforme Record ■

Public

Tout scientifique intéressé par la modélisation systémique, du disciplinaire au pluridisciplinaire ■

Pré-requis :

- Pas de pré-requis, mais vous serez amené(e) à discuter de codes, de statistiques et de mathématiques ■

Perspectives

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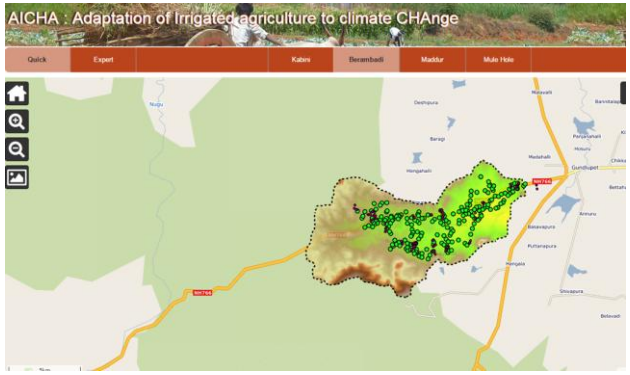
- **Supporting ongoing modelling works**

- **Packaging the different models** (documentation, examples …) and capitalizing on RECORD platform

ATCHA project

- **To improve the model(s)**:
  - by taking benefits from calibration of the model(s)
  - By Designing some validation tests
- **Data:**
  - Overcome scarcity of data
  - To benefit of the task concerning the improvment on the sharing of data (metadata, data integration …)

- **Distributed / semi-distributed model at Berambadi scale**
- Upscaling the model at a territory scale according
  → AICHA results (big survey, soil map ,soil moisture …)
  → Improvment of AICHA results
  → ATCHA scenarios to be designed



- **Vizualization of results**
  - Spatial Data Infrastructure → GeoSAS

- **Adaptation/design** new coupled model(s) and simulation interfaces, for scenarios

Thank you for your attention

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