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Simulation & Gaming to promote communication
between researchers, managers and blue swimming crab fishery communities
in Kung Krabaen Bay, Chanthaburi Province, Thailand.

Implementation of a participatory process using the Companion Modelling approach.

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"Tell me and I forget. Teach me and I remember. Involve me and I learn."
Benjamin Franklin

PREFACE.   INSTITUTIONAL CONTEXT

This project was based on a collaboration between the GREEN research unit of CIRAD center, Montpellier, France, and the Tropical Ecology Laboratory of Chulalongkorn University, Bangkok, Thailand. It followed a previous collaboration between these two institutes, the COMMOD / CU project (2004-2009)[1], that already allowed the implementation of several Companion Modelling processes in Thailand. These two institutes as well as the additional partners that approved and followed the project are presented below.

> GREEN research unit[1] of CIRAD research center, Montpellier, France.

CIRAD (Centre de coopération internationale en recherche agronomique pour le développement) is a French research centre working for international development. Most of its research is conducted in partnership with the all range of developing countries. It is a public industrial and commercial enterprise (EPIC) under the joint authority of the Ministry of Higher Education and Research and the Ministry of Foreign and European Affairs.

The GREEN research unit (Gestion des ressources renouvelables et environnement) belongs to the CIRAD Environment and Societies (ES) department. Its aim is to provide knowledge, methods and tools based on the modelling of complex systems to support collective processes for renewable resource management and to help stakeholders to improve their capacity to manage their eco-social system. In this objective, they participate to the research and development of a participatory approach calls 'Companion Modelling' (ComMod) which is now represented by an association of the same name (see below).

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[1] http://www.cirad.fr/ur/green

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➢   Tropical Ecology Laboratory, Chulalongkorn University[2], Bangkok,Thailand

'Chulalongkorn University (CU) is Thailand's first institution of higher education founded nearly a century ago. As a national intellectual center, the university produces the finest quality graduates with a high level of knowledge and skills in the arts and sciences that they can use to contribute to society.' (Professor Pirom Kamolratanakul, MD, President, March, 2009)[2].

The Tropical Ecology Laboratory belongs to Department of Biology of the Faculty of science. Its team offers courses on Man and environment; Principles of ecology for economists; and Society, business & environment. Research projects adopt a system modeling approach to forest or coastal environment or deal with the valuation of ecological services.

➢   Master EBE[3], Paris, France.

The master EBE (Ecologie, Biodiversité, Evolution) is a French postgraduate course in ecology discipline. It is taught in partnership with five French universities: UPS11, UPMC, AgroParisTech, ENS and MNHN. It aims to educate future researchers and practitioners who could understand and solve ecological issues. Their background will be a good understanding of the different components of socio-ecological systems, of their evolutions and their interactions.

➢   National Research Council of Thailand (NRCT)[4], Bangkok.

Thailand operates a permit system for foreign researchers. This permit is designed to promote research activities and enhance collaboration between Thai and foreign researchers by given them an official status and by facilitated the further used of the research results. This project was approved and followed by the Foreign Researcher Management Section (project id 2488).

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[2] http://www.chula.ac.th/cuen
[3] http://www.ese.u-psud.fr/masterEBE
[4] http://www.nrct-foreignresearcher.org

➢ Companion Modelling (ComMod) association[5], Paris, France.

Since 2010, this association under the French law status of 1901 brings together researchers and practitioners involve in the development of the Companion Modelling approach. This approach belongs to the participatory processes in the field of renewable resource management. It aims to tackle issues regarding decision processes, common property, co-ordination among actors, etc. Its originality come from: the repeated involvement of local stakeholders in its implementation; the use of modeling tools to represent the issues at stake (particularly Agent-Based Models and Role-Playing Games); and from the importance gives to collective debriefings of these models outputs (Etienne, 2010). Working with models and games has been a mean to cross disciplines boundaries and to recognize the complex nature of the systems under study. This approach should be understood as an ethic posture, rather than a modelling handbook, and it has been formalized in a charter (available in Barreteau, 2003).

➢ Kung Krabaen Bay Royal Development Study Center[6], Chanthaburi province, Thailand.

This management institute is a centre of studying, researching and experimenting on several topics that fit the environment and lifestyle of the local residence. Its started in 1981 from His Majesty the King project. Its five objectives are: (1) To study the structure of coastal resource management. (2) To become the training center and pass on the study outcome to the private and public sectors. (3) To enhance living conditions and occupations of the residence, especially for the poor residence. (4) To improve fishery and coastal aquaculture to increase the production volume of the country. (5) To preserve the environment to sustain the special characteristics of the area (Satumantpan, 2005).

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[5] http://www.commod.org
[6] http://www.fisheries.go.th/cf-kung_krabaen

CHAPTER 1.   INTRODUCTION: PROJECT PRESENTATION

1.1. Project justification.

In the actual paradigm of sustainable development, the linkage between natural resources and their use by the society is re-questioned. Nature is not seen anymore as objects' collections whose definitions are stated by scientists, but as complex socio-ecological systems (SES) identified by the society. It has been recognized that its definition is highly variable and depends of individual representations. It leads to the existence of several 'natures' and both practitioners as well as researchers stress the importance to implement natural resource management collectively by incorporating views of local stakeholders. Participatory approaches have then progressively gained popularity in territory management politics.

The Companion Modeling (ComMod) approach relies on the use of simulation tools to implement a participatory process. It aims at sharing representations among stakeholders and at improving their communication network, the quality of the discussion process being judged more important that its result itself. Indeed, in referring to post-normal science, it recognizes the importance of uncertainties and stochastic events which, in addition to the complexity of human behaviours, challenges the relevance of designing predictive expert models of SES. It is the improvement of communication between stakeholders that is seen as the key to enhance SES resilience. ComMod is used to enforce local resource users' self-organisation ability; and to strengthen their collaboration with territory managers as well as with researchers (Barreteau, 2003).

The purpose of this work was to implement the companion modeling approach to promote a better communication between local stakeholders of the blue swimming crab (BSC) fishery of Kung Krabaen Bay (KKB), in Thailand. It came out from a common interest of two students for this approach. Ecologist by training and always interested by communication sciences, I was eager to discover this approach by its practice and to contribute to the reflexive analysis of its actors' inter-relations. Miss Chutapa Kunsook, PhD student of Chulalongkorn University, in Bangkok, gave us the opportunity to implement a ComMod process in her study field. Indeed, involved since 2005 in the study of this crab fishery, she could highlight from one hand its biological specificities and from the other hand its social segregation leading to its difficult management.

1.2. Project objectives.

The project had a twofold operational and scientific objective:

➢ The first objective, related to development, was to collaborate with Miss Kunsook, to design and to implement a ComMod approach to promote communication between researchers, managers and BSC fishing communities in Kung Krabaen Bay.

➢ The second objective, related to methodological aspects of participatory modeling approaches, aims to experiment and question the collaboration work between scientific experts of the domain and approach designers; its pertinence for short term project (four months and a half locally); and the local co-supervision by previous PhD students who implemented a ComMod approach themselves, providing them the opportunity to transfer their skills and advise newcomers (see further, project monitoring part 1.4).

1.3. Kung Krabaen Bay' blue swimming crab fishery

Kung Krabaen Bay (KKB) is localized on the northern part of the Gulf of Thailand, in Chanthaburi Province, at around 260 km East from Bangkok (see figure n). Since 1981, with the development of His Majesty the King project, it is an important research field for the study and the conservation of natural coastal resources. Several universities, among which Chulalongkorn, and a Royal Development Study Centre (RDSC) are involved in the area (see these institutions' description in preface).

Moreover, it is an important economic site for fishery (notably for blue swimming crab (BSC) but also several other species of crabs, squids, fishes and shells), aquaculture (shrimp farms), and agriculture (rice farms, rubber plantations and orchards). BSC small-scale and commercial fisheries are a major economic resource in Thailand for local consumption as well as for exportation: in 2004, the total BSC yield in Thailand was 42.2 million ton with a value of 2,563.3 million Baht (= 35 million US$) and it represented the third national yield in the world in 2005 (Sawusdee, *et al.*, 2009). However, overexploitation induced by high market prices lead to a drop in production by 50% from 2000 to 2008. Despite this decline in catches, the economic yield decreased by only 9% on the same period, due to the increase of market prices (Department of Fishery Thailand, 2009, from Kunsook, 2005-2010). In KKB, the same trends were recorded.

In this context, to improve the understanding of the KKB ecosystem and to provide insights to support management decisions, Miss Kunsook started a PhD study in 2005. Her study focused on the BSC population structure and migration patterns at KKB.

Beside the academic research, the RDSC represents the main institution to develop and coordinate management actions in the area. A weakness of Thai fishery management often recognized is the out of date state of its legal acts (the main one being the Fishery Act dated of 1947) (Nasuchon, 2009). Its main strength is its politic of decentralization started since 1992 and favoring cooperation with local stakeholders (same author). The objective to focus on human as central for development to achieve resources sustainability was also recently enlightened in the Tenth National Economic and Social Development Plan (ONESDB, 2007-2010) given by the King. The RDSC of KKB plays this role of catalyst among the different stakeholders. Its officers organise regularly seminars to discuss management issues with local fishermen. They also experiment local management project For instance, a crab bank project started recently in Klongklud village with the creation of a center to receive and conserve harvested egg-bearing BSC females until they release their eggs (see details on crab bank systems on Suanrattanachai, 2009). However, it remained not used and local fishermen seemed poorly concerned in conservation issues. RDSC officers were then interested to follow our project to experience a new participatory approach aiming at promoting better communication with the fishermen.

1.4. The methodological approach.

ComMod approach originality is the use of models as dialogue tools to represent the system stakes. This paragraph presents the project use of models, data collection, monitoring and framework.

➢ <u>Different modeling tools: Agent Based Model (ABM) and role playing game.</u> The project first methodological objective was to build a baseline representation of the system which could be used as dialogue tool among local stakeholders. It aimed to be a dynamic representation including explicitly the agents of the system. Using this representation with stakeholders stimulate them to exchange on their interactions and on their effects on the system evolution. In this field of simulation, agents can be represented virtually, which correspond to ABM class of computational models, or they can be played by humans in role playing games; both tools allowing combined hybrid versions. In our case, we wished to implicate stakeholders as players, whereas the design of the

computational simulation tool seemed an adapted method to guide the conceptualization of our representation. The following modeling phases were then: to delimit our project domain, to conceptualise its representation via the construction of an ABM and to adapt this computational tool in a role playing game. These different phases and their links are summarized figure 1.
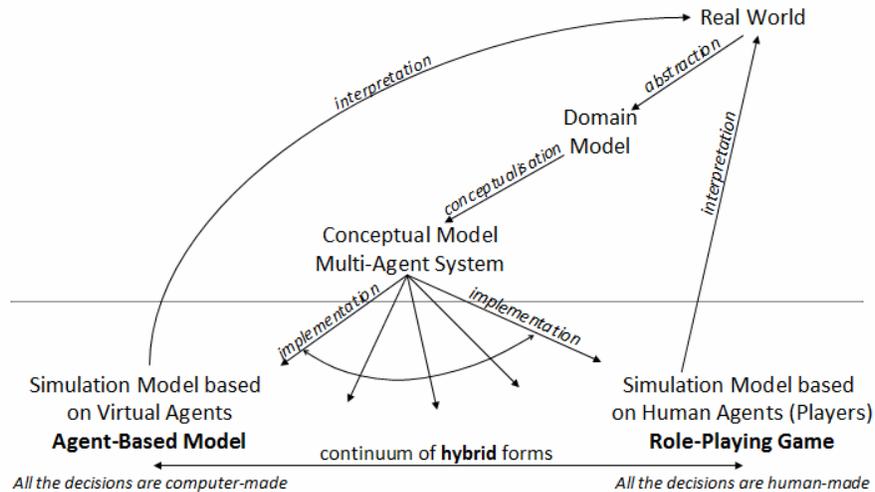
Figure 1: From reality to the implementation of simulation models based on agents (from Le Page et al., 2010).

➢   Data collection. Data used to construct our system representation were recorded by different ways: frequent discussions with Miss Kunsook, literature review, two field trips, and several interviews of stakeholders. Interviews were carried out in two times. A first field trip aimed to introduce myself and the project to local stakeholders. Meetings were led by open discussions and carried out mainly with stakeholders known by Miss Kunsook. It was the occasion to discover the area and I had the opportunity to be initiated to BSC trap fishery. A second field trip was organised to conduct a set of prepared interviews based on qualitative open-questionnaires to understand stakeholders' representations (see appendix 1). Stakeholders who were then interviewed were: all range of fishermen types (see point 1.5 our social delimitation); the village headmen and Miss Kunsook local facilitators in each village considered; prey shop and BSC market' owners (eleven interviews in total). A logbook was used to record details of all meetings. Methodology of workshop sessions recording is detailed chapter 4.

➢   Project monitoring. The project was monitored by my CIRAD advisor, Mr Christophe Le Page, based in Montpellier. During my stay in Thailand, we had regular

audio conferences (using Skype, which allows sharing computer screens). Additionally, a local co-supervision was provided by two post-PhD students, Mr Pongchai Dumrongrojwatthana and Mr Kobchai Worrapimphong, who just finished similar projects and who could thus take over the relay of advisors.

➤ Project framework. The project framework is presented figure 2. Four months and a half were spent in Thailand, hosted by the Tropical Ecology Laboratory of Chulalongkorn University in Bangkok (see detailed section on its institution in preface). One field trip per months was organized to create continuity in our exchanges with local stakeholders. Two first ones were described above. The third one was the workshop implementation and the last one aimed to evaluate its feedbacks. In between the part in Thailand, the project also included two stays in the GREEN research unit of CIRAD, in Montpellier. During these periods, two main events can be enlightened: one week training course to Cormas software and Smalltalk computational language before the departure to Thailand; and the project presentation in ComMod association' seminar at our return.
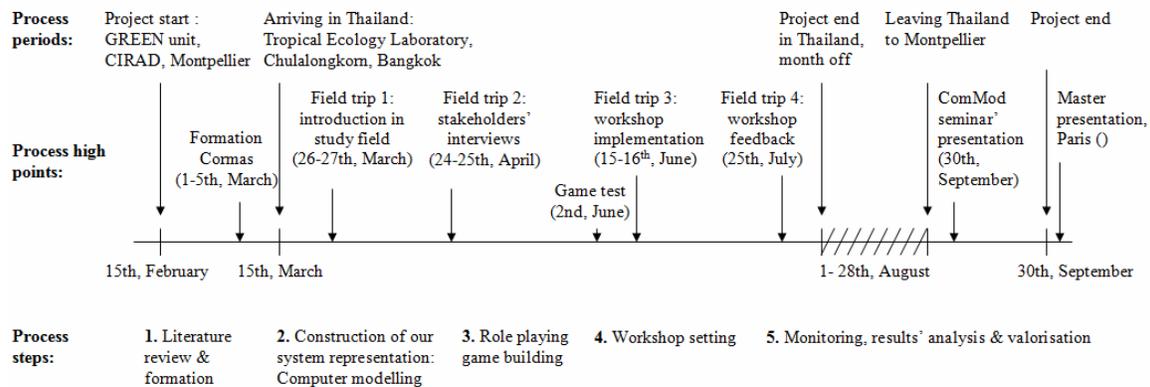
Figure 2: Methodological framework.

1.5. Project study site delimitation.

Collaborating with Miss Kunsook, she introduced me to the field and therefore the project site delimitation was set up accordingly to her PhD work. Its description can be separated under three components as following:

➤ Geographical delimitation: KKB is a small (2.6 km wide and 4.6 km long) and shallow (maximum depth: 8 meters) system. Its semi-enclosed state (bay mouth: 650 meters wide), led to the distinction by local fishermen of two different fishing zones: the 'bay' and the 'sea'. This strong separation in fishermen representations is questioned by

scientists regarding the biotic distribution among these two areas. Do they correspond to the habitats of two different populations or rather to the habitats of two subpopulations belonging to one common population? The distinction between the two BSC groups of the bay and the sea being made, and the definition of the FAO fisheries glossary[7] for habitat being 'the place where an organism lives', we distinguished one habitat per fishing zone. A population is defined by the FAO fisheries glossary as 'a group of interbreeding organisms that represents the level of organisation at which speciation begins'; while subpopulations correspond to 'distinct groups in the population between which there is little exchange'. The actual state of research suggested that it is two subpopulations and it is the hypothesis that we kept in this project. Indeed, Miss Kunsook capture-mark-recapture experiments, showed an effective migration of BSC individuals from the bay to the sea (Kunsook, 2005-2010); and Mr Tantichaiwanit study on zooplankton dynamics suggested that both BSC groups of the bay and the sea are contributing to the same common pool of larvae (Tantichaiwanit, 2010). Both areas 'bay' and 'sea' were then included in the project to stimulate discussions on the topic of BSC spatial distribution between the different stakeholders. However, the global BSC population on which KKB fishery harvest is probably even widely spread in reality, as 'sea' was delimited in this project to the coastal zone in front of the bay with roughly the same surface area than the bay.

➢ Biological delimitation: The project was limited to the BSC species even if other species are harvested as by-catches by BSC fishermen. To describe BSC subpopulations, a differentiation by sex, size (carapace length) and female bearing eggs or not was selected to allow considering interesting economic and conservation aspects. As a matter of fact, BSC value increases with its size and it is commonly argued that overexploitation is worsened by high catches of immature crabs and egg-bearing females.

➢ Social delimitation: The project was limited to the local fishermen targeting BSC, excluding other fishermen in the area who harvest BSC as by-catches. Even if trawlers recently arrived in the nearby off-shore area, it was decided to consider only small-scale fisheries. Among local BSC fishermen, different types were distinguished, based on their fishing gears: traps or nets, and their fishing zone(s): bay or sea or both. Representatives of both gears' types are represented in each fishing zone(s) category. Each gear type has

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[7] http://www.fao.org/fi/glossary/

different characteristics of use, selectivity and catchability. The selectivity being defined by the FAO fisheries glossary as 'the ability to target and capture preys by size and species'; and the catchability as 'the measure of fishing mortality generated on a stock by one unit of effort'. A social disconnection exists between all these different types of fishermen. Net users notably blame trap users to harvest immature crabs by using a too small mesh size (Kunsook, 2005-2010). In consideration to the cultural custom to avoid confrontation, the term of 'disconnection' seems more appropriate than 'conflicts'. Finally, this project study site delimitation included three villages located around the bay as illustrated in figure 3. Their villagers' inter-exchanges are very limited even if colleagues meet during fishing activities. These three villages have different size and different representation in term of fishermen types: see table I.
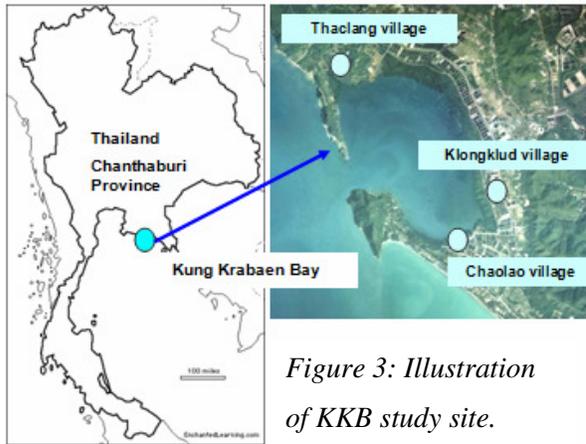
Figure 3: Illustration of KKB study site.

Table I: Characteristics of KKB villages.

Village name	BSC fishermen home	Fishermen types
Thaclang	~100	bay / sea / both trap / net
Klongklud	~ 25	bay trap
Chaolao	~100	sea net

CHAPTER 2.   DESIGN OF THE 'KKB' AGENT BASED MODEL

Agent Based Models (ABM) are a class of computational models used to represent autonomous agents situated in a common environment and to simulate their actions and interactions while keeping a view on the system as a whole to assess their individual effects at the micro-level on its evolution (at the global level). The ABM described here corresponds to a personal representation of the study site that emerged from a literature review and from the direct interactions with Miss Kunsook and with local stakeholders.

2.1. Description of the conceptual model by ODD protocol.

ODD (Overview, Design concepts, and Details) is a protocol proposed in 2006 to standardize and publish descriptions of individual-based and agent-based models (Grimm *et al.*, 2006). It organises the description under several elements followed below.

Overview:

➢   Purpose. This model was built to represent our understanding of KKB BSC fishery socio-ecosystem. It allowed us identifying its influential entities, variables and their inter-relations as well as assessing system uncertainties. Moreover, it was used as a dialogue tool through its co-construction with Miss Kunsook and as a guideline to organise the literature review. In a second stage, it aimed to be adapted in a role playing game to promote communication between local stakeholders.

➢   State variables and scales. The model is structured as a set of modules, each module being made of inter-related entities. Entities are characterized by a set of state variables and a set of operations. Modules, entities, state variables and main operations of KKB model are illustrated in a UML[8] class diagram figure 4. The model structure is described below.

Accordingly to our study site delimitation (see point 1.5), three modules were distinguished in KKB model: a spatial module, a biological module and a fishing module. The spatial module is composed of one fishing zone entity and one habitat entity. A fishing zone refers to the fishermen representation and is characterized by an area and a label: 'bay' or 'sea'. A habitat refers to a biotic distribution and is characterized by a carrying capacity. The biological module is composed of two entities: the females of a BSC subpopulation and the males of a BSC subpopulation. These entities are similarly characterized by: an age class distribution in 1-month age classes (straightforwardly correlated to a length class distribution), a natural mortality rate and a migration rate. Four additional variables are specifically associated to 'the females of a BSC subpopulation' entity: a sex ratio, a maturity age, a reproduction rate and a fertility rate. In a given habitat, the males and the females of a BSC subpopulation are paired. As detailed part 1.5, we made the hypothesis that each fishing zone corresponds to a different habitat, each habitat being the location of one BSC subpopulation, and the two subpopulations are linked by migration processes and a shared recruitment. Finally, the fishing module is composed of three entities: the fishermen, and two fishing gear entities, the traps and the nets. Traps and nets are both characterized by a specific selectivity and catchability (as defined point 1.5). Fishermen are characterized by a collection of fishing

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[8] "Unified Modeling Language, see http://www.uml.org/

gears. At each time step, they can update the size of this collection and then they have to decide the location of each fishing gears on fishing zones.

The spatial scale is defined by the two fishing zones as the two model space units. To fit the biological module, the model time step was set to one month and the model was calibrated for a time horizon of ten years.
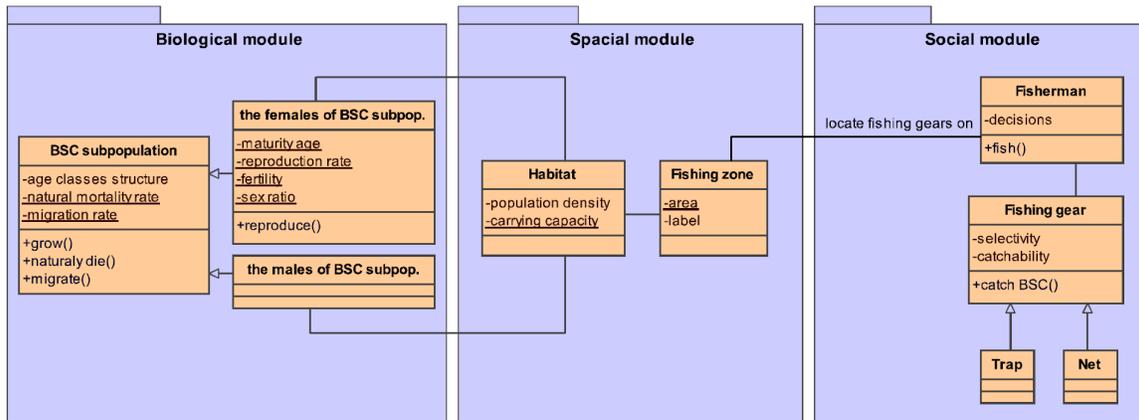
Figure 4: KKB model UML diagram. Boxes represent model entities with in the middle part their state variables and in the lower part their operations. Simple lines indicate inter-relations, an ending triangle signifying a specialization.

➢ Process overview and scheduling. Within each month (time step), six phases are processed in the following order: (i) all BSC subpopulations growth, (ii) a part naturally die, (iii) the females of the BSC subpopulations reproduce, (iv) new recruits are equally shared between each BSC subpopulations; (v) fishermen go fishing; (vi) a part of each BSC subpopulation migrates. The phase of fishery is split into three actions: (i) fishermen locate their fishing gears in fishing zones; (ii) the fishing gears catch some BSC that are removed from their respective BSC subpopulations; (iii) fishermen take back their fishing gears and catch data are recorded.

Design concepts:

➢ Design concepts.

Emergences: Model system emerging phenomena are fishermen decisions' evolution and their impacts on the evolution of the biological module. Indeed, BSC life cycle and migration processes are fixed in the model. Thus, BSC subpopulation density evolution is directly linked to the fishing activities.

Adaptations: However, the BSC subpopulations' fitness is density dependent. Indeed, habitats are characterized by a carrying capacity which limits females' fertility. Below this limit, their fertility increases with their density decrease. Fishing gears' catchability is of course dependent of the BSC subpopulation density.

Predictions: Predictions of the model evolution is then a decrease of the BSC subpopulations' density in case of over-exploitation, which can go until their total extinction; or their increase until their habitat carrying capacity in case of under-exploitation.

Stochasticity: from the catchability of a given fishing gear and the BSC density in the fishing zone where the fishing gear is located, the number of crabs to be caught by the fishing gear is computed. Then, to determine in which age class to select these crabs, there is a probabilistic function based on the frequency of each class.

Observations: For testing, understanding, and calibration of the model, probes were defined to track the evolution of several variables, as presented table II.

Table II: KKB model probes.

BSC subpopulations	Habitats	Fishing zones	Fishermen
total size	BSC pop density	net amount	gears in bay
recruit number	emigrant number	trap amount	gears in sea
natural death number	immigrant number		catch in bay
age classes structure			catch in sea

Details:

➢ Initialisation. At the start of a simulation run, model entities are created in the following order: two fishing zones ('sea' and 'bay') are created; two corresponding habitats are created and; one pair of males and females of a BSC subpopulations is created in each habitat; and finally a free number of fishermen are created. Fishing gears are created separately when needed during the simulation. The initial age classes' frequencies of the BSC subpopulations are imported from a common Excel file. It pre-defines an age distribution already influenced by fishing activities and allowed to always start with the same initial situation. This file was created from a previous simulation wherein the BSC subpopulations at equilibrium (having archived their habitat' carrying capacity) were exposed to a baseline fishing activity. The initial values of the different state variables are presented with their references in table III.

Table III: KKB model state variables, their initial values and related references. References'
numbers refer to our bibliography.

Model state variables	Initial value	References
BSC subpopulation entities:	**Male or Female**	
Age classes structure	1 to 36 1-month age classes	literature (16,10,15,3,5,6,19,8)
Natural mortality rate	0.13	literature (16,15,5,3)
Migration rate	0.04	hypothesis
Sex ratio (females only)	0.5	literature (14,9,3)
Maturity age (females only)	3 months	literature (11,17,19,14,3)
Reproduction rate (females only)	a collection of monthly percentage, starting from October: (40,40,25,25,40,40,25,10,10,10,10,2 5)	literature (5,19,9,10,17,3,1)
Fertility (females only)	0.805	calibration
Habitat entities		
Initial subpopulation density	1 crabs/m3	fixed
Carrying capacity	10 crabs/m3	fixed
Fishing zone entities		
Area	300,000 m3	fixed
Label	bay or sea	/
Fishermen entities		
Decisions	set of fishing gears / fishing zones	/
Fishing Gear entities:	**Trap or Net**	
Selectivity	2 months or 4 months	literature (2,9,10)
catchability	100*pop density/day or 200*pop density/day	literature (2,9,10)

Regarding the literature review, data used in the model were as much as possible
taken from works conducted in KKB or considering the locality of the other referenced
papers. Indeed, it has been found that BSC life cycles highly vary between locations,
notably with latitude (Kangas, 2000; Dineshbabu, 2005). This attention in choosing the
values of the parameters aimed to assess the state of existing knowledge and to highlight
scientific uncertainties. Many aspects related to the biology of BSC remained unknown,
however, we did not aim to build an expert model and therefore, some unclear values
were roughly approximated to represent the system tendencies, with the idea to discuss
them with the stakeholders.

➢ Sub-models. This last part aims to detail all processes described above to allow
their full understanding and the model duplication. This part is presented in appendix 2.

However, if the model allows following the evolution of the age classes distribution;
in reality, the determination of ages is very difficult and indicators are based on carapace
lengths. Then, we needed to convert our model outputs. This feature, common to many

species in tropical water, leads to the design of length-based models to estimate growth parameters. From these models, the correlation age/length can be calculated by a standardized equation: the Von Bertalanffy growth equation (1) (Sparre, 1998; still cited as reference in the updated version Gayanilo, 2005).

	With:	$L(t)$: carapace length (cm) at age t (months)
		$L\infty$: maximum carapace length (cm)
(1) $L(t) = L\infty*(1-e^{\wedge}(-K*(t-t_0)))$		K : growth rate
		t : age (months)
		t_0 : initial condition parameter

From the literature, growth parameters selected were: $L\infty$: 20 cm; K: 1.4 and t_0: -0.041. We used these parameters values to build the correlation age/size used in our model.

2.2. Implementation under Cormas software.

The conceptual model was implemented with the Cormas platform, a generic agent-based simulation software developed by the Green research unit (Bousquet et al., 1998) using the object-oriented programming language Smalltalk.

Two main features were added to the conceptual model at its implementation to allow its utilisation in a role playing game. To allow the connection between fishermen' virtual agents and players, an interactive interface was built to input players' decisions. Based on our game design (see chapter 3), this interface was opened every twelve time steps to account for yearly decisions. Decisions inputted were then re-used at each time step (month) during one year. Based on our game indicators (see chapter 3), an Excel file was then constructed to receive and organize the presentation of several model outputs.

CHAPTER 3. DEVELOPMENT OF THE 'IdeasFishery' ROLE PLAYING GAME

3.1. Game rules' design.

Game rules were designed by considering three guideline choices: to focus on communication among participants; to create a simple game with few rules but many indicators as a wide angle panorama to be refined collectively; to provide public display of information to encourage exchanges.

➢ Number of participants and villages' representation. To avoid a loss of exchanges' quality, the number of participants was limited to ten players and few observers. Three

villages were included in our study area. However, the invitation of a too small number of participants from each village would have not allowed their good representation. It was then decided to design a game for ten players equally divided in two villages and to simulate the action of a third community composed of five fictive fishermen. An equivalent number of players per village was wished to insure equity. The simulation of one village also allowed discussing the effects of actors involved in the system but outside of the communication arena.

➢ Players' profile. Players' profiles were defined with the aim to ease participants' identification. Each participant played a fisherman with a profile similar to his status in reality and determined by 4 characteristics: a village origin, a fishing area (composed of one or two fishing zones), a fishing gear type (net or trap) and an initial number of gears. It was decided that the profile of a player should be easily accessible to everyone by its notification on id tags and by assigning specific colors to each village and to each player. To mark the game schematic nature, villages and players names were replaced by numbers. At the game initialisation, players would thus receive a kit composed of: an id tag noticing their profile, a game sheet, a variable number of gear cards and a pen.

➢ Players' goal. Players' goal was defined as: to harvest enough crabs to satisfy their needs year after year. This formulation allowed referring to individual ambitions as well as to a sustainable management.

➢ Time step and players' decisions. To achieve their objective, players would have to decide the number and location of their gears during the fishing session. When designing the game, the key question was: which time step to select for fishermen decisions and game results? On the one hand, biological and social representations had to be considered. The biological module of the model ran monthly. However, we found out from interviews that fishermen had a daily representation of their activity. Their daily gears' number and location do not change that much - yet it can be adapted to the weather conditions, notably during the monsoon season. Though, daily catch presents a high monthly variation. On the other hand, the game dynamic requests a time step not too short to allow reaching by the end of a session (after a few turns) a situation that is slightly different from the initial one. . Thus, it was decided: to simulate one year by one game turn wherein players would decide their fishing actions (number and location of

their gears) for one day representative for this year; the system monthly variations would be introduced by the game indicators.

➢ Game indicators. Game indicators aimed to offer to stakeholders a wide set of discussion elements on the system evolution and to look at how participants would make them theirs. They were built by considering stakeholders' representations via individual interviews (see data collection methodology). They can be divided in three types detailed in table IV and defined as:

- *Indicators of players' decisions*: These indicators are published on the game board to provide a synthesis of players & gears number per gear types and per fishing areas.

- *Indicators of BSC subpopulations' evolution:* It consists of two density indexes, one per subpopulation, arbitrarily initiated at 1 to allow monitoring the evolution of BSC subpopulations. It refers to a scientist notion and its value is not available in reality. However, it was thought interesting to introduce it in the game to emphasize the direct link between crab subpopulations evolution and fishing activities; and to provide both scientists and resource users' representations.

- *Indicators of catch results:* Accordingly to everyone's decisions, players obtain at the end of the turn their respective catch amount for one day representative for the year. Additionally, information about catches at the community level are displayed as: monthly variations of catches and of ovigerous females harvested, as well as the distribution of BSC harvested size classes and the total catch amount.

Table IV: IdeasFishery indicators. FZ: fishing zones.

Game results' indicators (for one day representative of one year – except notification)		
Indicator type	Information communicated	Access
Players' decisions	observation of players' gears' number, type and location on FZ	Public (game board)
	players & gears total number / FZ	Public (results notice board)
	players & gears number / gear type / FZ	
BSC subpopulations' evolution	BSC subpopulation density index / FZ (at the end of the turn)	
Catch results	BSC harvested total number / gear type / FZ	
	BSC harvested size classes' pie chart distribution / gear type / FZ	
	monthly variation of BSC harvested graph / gear card type / FZ	
	monthly variation of ovigerous female harvested index / gear type / FZ	
	number of BSC harvested individually	Private (game sheet)

➢ <u>Gaming areas.</u> Four different gaming areas were devised: two village places composed of a circle of chairs; a fishing area represented by a game board divided in two fishing zones; and one collective domain to publicly display game results. It was decided to separate players per village at the game initiation. Village places would be lay apart to recreate their distance in reality and to observe the setting up of communication considering this obstacle. Separation in space of villages and of the fishing areas seemed also important to put players in action physically and to give them the opportunity to re-organise by themselves. Finally, it was though interesting to open the access of a shared domain and to observe its use by participants.

➢ <u>Game sequence.</u> The game sequence of one turn articulates players' actions in the different gaming areas. A turn of play is made of four gaming (figure 5).

2: Then, they bring it to the computer desk for registration of their decisions under KKB model.

1: From their village, players write their fishing decisions on an individual game sheet.

3: After that, they gather around the game board to locate their gear cards on the chosen fishing areas. Simultaneously, KKB model runs for one year and game public results are printed while individual catches would be reported on players' game sheet.

4: Finally, public results are displayed in the collective area. Players take back their gear cards and return to their village places, having received back their game sheet, ready to start a new turn.

Figure 5: Gaming steps of IdeasFishery.

➢ <u>Additional rules</u>. On the third turn, an announcement is made by the game master to offer to players the opportunity to acquire for free one or two additional gears of their choice.

➤   <u>Play ending.</u> The game ends after four turns but this limit can be extended up to six turns. At the end of the game, 15 minutes break are given to players after what a collective debriefing is organised to discuss the game events.

➤   <u>Game scenarios</u>. To initiate a discussion on the function of communication among the community, two different communication scenarios were proposed: one forbidding exchanges among villages and one offering a five minutes free consultation time (extendable) between each turn. To evaluate participants' spontaneous use of exchanges, it was decided to announce the ban of communication only if necessary.

➤   <u>Game supports</u>. This design led to the construction of several game supports: a set of player kits, a game board, a results notice board. Additional information boards were also created to make explicit all indicators and therefore to open them clearly to discussions. A computer with KKB model software and a printer were also necessary.

3.2. Construction of game supports.

Game supports have to be easy to understand and to manipulate for all participants. Moreover, their symbolism needs to be questioned in the cultural context. For example in our case, red and yellow colours were excluded due to their political connotation. All the game supports are illustrated in box 1 and some of their features are detailed below.

➤   <u>Player kits, game board and results notice board.</u> These elements were built following the rules' specifications. Regarding the gear cards, they were represented by a trap or net drawing and symbolized one unit of fishing pressure without correlation to a real number of gears. This enlightened the schematic nature of the game and its role of dialogue tool rather than expert tool. Colour sets selected were: to print id tags and player game sheets in differently coloured papers for village 1 (pink) and for village 2 (blue); to use coloured post-its as player-code on their id tags, game sheet and gear cards. Game indicators were displayed in several forms (graphs, pie charts, index and numbers) as presented in table IV.

➤   <u>Information boards.</u> Two information boards were created. One specified the distribution of BSC size classes, the sexual maturity size, and the correlation with trap and net mesh sizes. It was associated to real BSC carapace shells and rulers. The second one characterized gear cards' catch expectation considering gear types and subpopulation density index. It also informed the characterization of ovigerous female recorded.

Box 1.   Illustration of IdeasFishery game supports

1 : player kit. 2 : game board. 3 : results bulletin board. 4 : third village player' counter. 5: information boards. 6: BSC carapace shells. 7: a computer with KKB model software and a printer.
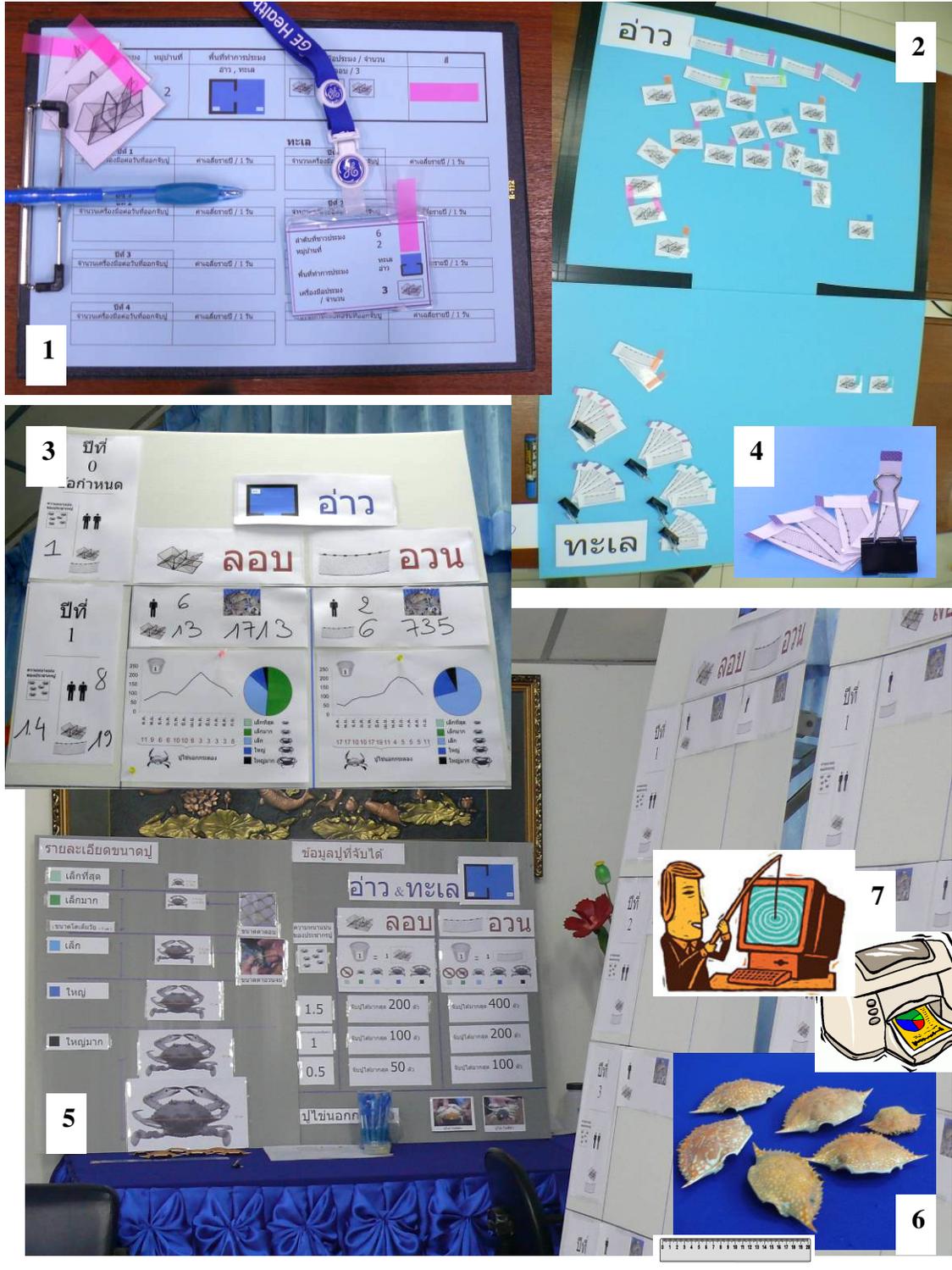
3.3. Game tests.

Before implementation, game tools and sequences were experimented with five undergraduate students from Chulalongkorn University. It influenced the game design; and it notably encouraged the collectivization of all indicators results to open information exchanges and to reduce printing time. An example of public result sheet in its last version was then presented to few local stakeholders to test its legibility.

CHAPTER 4.   GAME ORGANISATION WITH LOCAL STAKEHOLDERS

4.1. Choice of participants and determination of their gaming profiles.

Considering the game limitation to five players per village, to invite participants from two villages, the selection criteria were:

➢   To play with Klongklud and Thaclang villagers. Indeed, they formed a pertinent group by representing 90% of BSC fishermen in the bay (Kunsook, 2005-2010). It was also the two villages were Miss Kunsook had the main contacts and Thaclang offered the highest diversity among fishermen.

➢   To invite local facilitators as players and village headmen as observers. The involvement of local facilitators in game action seemed important regarding an objective of approach transmission. Moreover, they have a major role in group cohesion. Village headmen are influent stakeholders who can support further process development. Their social status required a tactful consideration and they were invited as observers.

➢   To respect real fishery categories' distribution in gear type and fishing area.

➢   To select participants able to defend their interests and likely to disseminate their experience. These features were evaluated from our interviews as well as on Miss Kunsook, her local facilitators and the village headmen suggestions.

➢   To favour stakeholders known by Miss Kunsook. Thus, she could better interpret their behaviours in game by comparison to reality.

➢   To invite KKB RDSC representatives as observers, with the objectives of influent actors' inclusion and of approach transmission. The center director and Miss Kunsook contact were invited but only this last one joined the group.

Additionally, four NRCT representatives requested to participate to monitor our project and we were five researchers to manage the workshop (see team organisation point 4.3).

Accordingly, the list of participants' selected is presented Table V, with the profiles of players.

*Table V. List of participants and players' profiles.*

Players: status, name and game profile	
Players status in reality: village, role, name, number & type of gear, fishing areas, + indicates players' guests	Players profiles in game: village number & colour characteristics, id number & flag colour, number & type of gear card, fishing areas

Klongklud village:
 Fishermen: Pi Sak (200 traps, bay) +wife
     Lung Tode (200 traps, bay)
     Lung Meng (200 traps, bay)
     Pi Chamlong (300 traps, bay) +wife 2nd day
 Facilitator (ex- trap fisherman, bay): Pi Noi
	Village 1: pink id, half-coloured flags
	 fisherman 1, light-bleu, 4 trap cards, bay,
	 fisherman 2, pink, 4 trap cards, bay,
	 fisherman 3, dark-bleu, 4 trap cards, bay,
	 fisherman 4, orange, 6 trap cards, bay,
	 fisherman 5, purple, 4 trap cards, bay,

Thaclang village:
 Fishermen: Pi Nid (160 traps, bay & sea)
     Pi Boonrod (250 traps, bay & sea)
     Pi Theep (10 nets, bay & sea)
     Pi Samroeng (20 nets, bay)
 Facilitator (Pi Samroeng' daughter): Pi Nwoo
	Village 2: blue id, full-coloured flags
	 fisherman 6, pink, 3 trap cards, bay & sea,
	 fisherman 7, light-bleu, 5 trap cards, bay & sea,
	 fisherman 8, purple, 5 net cards, bay,
	 fisherman 9, green 3 net cards, bay & sea,
	 fisherman 10, orange 4 net cards, bay & sea,

Chaolao village: Only net fishermen, fishing in sea area, Represented by 5 fictive players (counters)	Village 3: spotted flags fishermen 11,12,13,14,15, 5 net cards, sea flag colour: green, purple, mauve, pink, bleu
Observers: status and name	
Klongklud village headman: Mr Imsarapang Thaclang village headman: Mr Narongdech (present only the 2nd day)	
KKB Royal Development Study Centre officer: Pi Solanan	
NRCT, foreign researcher management division, team: Ms Pannee Panyawattanaporn, Ms Amara Vijita, Ms Yada Sammarat, Ms Rapeeporn Roegputi.	
Researchers: status, name and management role	
* All researchers were from Chulalongkorn Tropical Ecology Laboratory, except Mr Bhatasatapornkul from Burapha University, Chanthaburi campus.	
Chutapa Kunsook: workshop manager Elsa Leteurtre: computer manager Pongchai Dumrongrojwatthana: facilitator first village Kobchai Worrapimphong: facilitator second village Thachanat Bhatasatapornkul: Elsa' facilitator	

4.2. Workshop schedule and location.

➢   <u>In KKB RDSC, the 15th and 16th afternoon of June, from 12.30pm to 5pm.</u> Game Selecting the place to organize a gaming session can influence power relationships likely to occur during gaming sessions. Usually game developers try to find a neutral location such as the village school. In our case, we wanted an area apart from both villages concerned to insure more equity. KKB RDSC presented this advantage. Moreover, it is a

current gathering place between villages during this agency conferences and it offered the required equipments. Though, we recognise that it was not a neutral place and with more time an alternative may have been found. Afternoon sessions were decided regarding fishermen availabilities: they are used to go fishing on mornings. It also allowed us to keep free morning of the second day to adapt the game if necessary and to discuss our project with NRCT members. It was planed that Thaclang villagers, far from the gathering place, would be picked up by van, while Klongklud villagers would come on their own. Players received a compensation of 300 baths per day (500 baths for local facilitators) which was not announced in the invitations.

➢ <u>Workshop sessions' timetable and room setting</u>. One afternoon represented one workshop session and one game scenario. Each workshop session followed the same schedule: a short introduction, a game scenario play, a break, a collective debriefing, and a set of individual interviews. Game plays ran for around 1 to 2 hour and collective debriefings for around 1 to 1 hour and a half (second session being longer than the first one). Considering game features, the workshop room was set in a way to separate the four gaming areas: the two villages, the game board and the public results board. Observers' desks were laid out in stand back and informative posters on similar experiences were hanged at the back of the room. Space setting is illustrated figure 6.
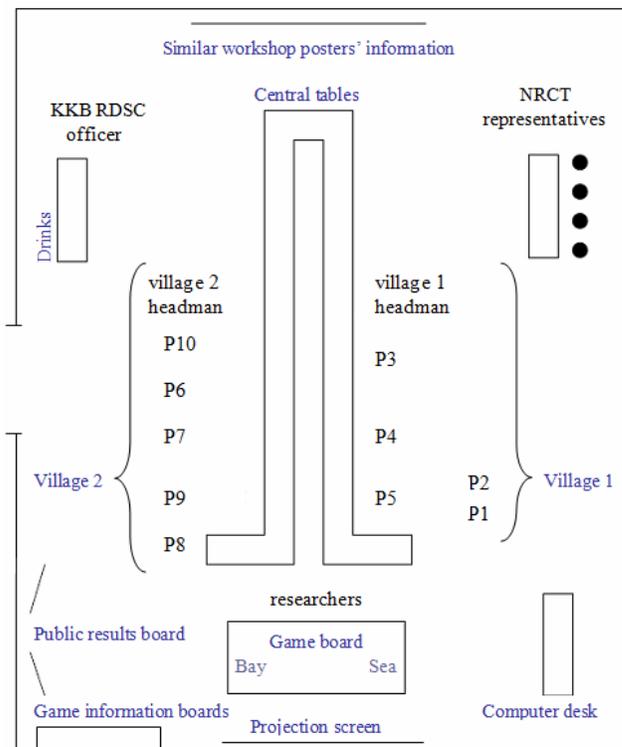
Figure 6. IdeasFishery room setting and participants' disposition.
Pn = Player number n. P5, P10: local facilitator; P8, P9, P10: net fishermen while others played with traps (cf. complete list of players' profile, Table V). Participants kept the same place during the two days. Village 2 headman was present only the second day.

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4.3. Workshop management and monitoring.

➢ <u>Team organisation for sessions' management</u>. The workshop was led in Thai by Miss Kunsook while our two colleagues experimented in ComMod approach played a role of facilitator for each village. I was software manager: recording data, printing and displaying game results. A fifth partner assisted me to follow Thai discussions. The way of leading the process was discussed in advance in order to avoid interruptions as much as possible. However, when new questions arose, my colleagues came ask me how I wanted to answer them. Game debriefings were conducted based on collective analysis of results during break times. After each game session, interviews of participants were translated in English and researchers' perceptions were debated. The brainstorming following the first afternoon was completed by a Skype exchange with my CIRAD project advisor before we agreed on next session adaptations. Despite assistance, game conduction was absorbing and in practice it was difficult to follow all events and discussions. Besides to limit individual sensibility bias, multiplicity of observer appeared then essential.

➢ <u>Data collection.</u> Workshop sessions were recorded by several methods: saving of all model inputs and outputs, collection of individual and public game sheets, realization of a set of photography, and recording of researchers' cross-observations. Moreover, participants' feedbacks were collected via individual questionnaires at three different intervals: after each afternoon by researchers and after one or two weeks by telephone.

CHAPTER 5. WORKSHOP ANALYSIS:
SEQUENCES OF EVENTS & GAME RESULTS

For more legibility it was decided to separate the description of workshop events and the analysis of participants' feedbacks (chapter 6). For the same reason, a chronological narration was the method selected to present workshop sessions.

5.1. The use of game indicators by participants and choice of results' presentation.

One objective of the workshop was to observe participants' use of game indicators. During first turns, participants all gathered in front of the bulletin board to watch public

results displayed; then the bulletin board was partly left aside, as participants focused mainly on their personal outcomes(individual catches re presented in table VI, while appendix 3 summarizes players' strategies made explicit in individual interviews). Public results were mainly discussed during debriefings and focused on: the evolution of gear cards number (Unit Effort), the related Catch Per Unit of Effort (CPUE) and its consequences on BSC subpopulations density index. These results are presented table VII. Evolution of total catches, BSC size distribution, monthly variations of catch amount and ovigerous female harvested index were appreciated in interviews as realistic elements (see appendix 6) but not discussed. Their evolution is presented in appendix 4.

5.2. First session description.

➤ Scenario: No communication; Objective: To create a baseline reflecting the lack of exchanges in reality, by forbidding communication between players (if they were to spontaneously engage in collective discussions).

➤ Introduction: After stakeholders' presentation, Miss Kunsook opened the meeting by a short introduction on her project progress, its link with our collaboration and the game presentation.

➤ Main game events: A period of confusion followed the game start and participants spontaneously exchanged collectively to clarify rules. Researchers tried to stand back by answering questions on a case by case basis. From second turn, everyone understood well all sequences and game ran smoothly for around one hour, players taking fast decisions. If non-communication rule was announced at first turn disorientation, it was probably not necessary and any enforcement was requested. At the play beginning a wide range of gears number was used (partly due to misunderstanding); but then all players increased their fishing pressure and only one did not requested additional gears. All expressed the same individual strategy: the need to increase gears number to maintain their catch. However, if some aimed only to get the highest production, others adopted a more progressive increase, considering carefully their choices by referring to additional real factors such as gear maintenance or their own needs and work capacity. BSC subpopulations' density and CPUE indicators sharply declined inversely to fishing pressure without any change in player behaviours. Decision times did not appear to be longer either.

➢   <u>Debriefing</u>: Three main points were then discussed collectively: game tool perceptions, game results and game improvements. First and third parts are detailed in appendix 6. Regarding game results, participants found them realistic but uninspiring. Discussions were slow to start and mainly in a question-answer way between researchers and individual players. However, when they were requested to imagine solutions to avoid CPUE decrease, exchanges drifted to a collective but confuse state. Players talked more directly to each other and mentioned diverse management actions which largely out-scaled game representations such as crab bank or budget handling.

5.3. Second session description.

➢   <u>Scenario</u>: set of five minutes consultation time (extendable) between each turns; <u>Objective:</u> To encourage communication among players.

➢   <u>Introduction</u>: After the first day, it seemed that the influence of others' actions on individual catches and the direct link between the total fishing pressure and the BSC subpopulations' density was not clear for players. Indeed, all recognized they did not pay attention to others' way of playing further than 'good' locations on gear board and several mentioned the unpredictability of catch variations. It was then decided to start the session with a brief discussion on two simulation graphs showing the evolution of the BSC subpopulations' density related to different fishing pressures. The first scenario was based on the four turns of the first gaming session with additional two years under the same fishing pressure as in fourth turn; while the second one presented the situation where all players would have used for five years only one gear less than their maximum. The first scenario led to subpopulations extinction while it increased in second scenario. The link between fishing pressure, BSC subpopulations' density and individual catches was then re-opened to discussions. Moreover, it allowed researchers to elaborate on the role of the computer and to question the fatalist picture of BSC subpopulations' decrease.

➢   <u>Main game events:</u> It was then proposed to participants to play again but with the possibility to coordinate through collective discussions, as mentioned above. The opening of the game session was again confusing: participants shared comments collectively before asking researchers if the aim of this new gaming session was to increase crab subpopulations density. They were answered that fishermen aim did not change: it was still to harvest enough crabs to satisfy their needs years after years. Discussions continued

a bit among players. The most talkative participants enunciated that crab subpopulations' density should be taken into account but justifications and consequences on their fishing behaviour remained unspecified. No clear approval from all players was requested and game decisions during the progress of the game were not controlled. Consultation periods between turns remained then underused as players did not want to use them anymore. During the first year, all players used less gear than their maximum. Then, strategies were diverse but all kept a relative low number of gears: only four reached their maximum and nobody requested additional ones. As game was running in an easy way with still little interest of players for collective actions, we decided to double the third village' fishing pressure during the fourth year. This technique of breaching aimed to disrupt the course of actions in order to provoke thinking and to take a new look at situations (Daré, 2005). A fifth game turn was added to allow players to react. However, none of the participants seemed surprised. The event was not discussed among players and except player 9 who used one more gear than her baseline decision, no change in the behaviours of players was observed. CPUE and BSC subpopulations' density indexes, which were first increasing, decreased strongly in the sea zone from this fourth turn, followed by a decrease in bay in the fifth turn due to the effect of migration.

➢ Debriefing: We came back on this event during the collective debriefing. Participants acknowledged that it could actually happen because a lot of fishermen are present in the area and even people from other villages far away are now fishing in this zone. Then, they spontaneously mentioned additional influent actors such as other fishermen for whom BSC is an important bycatch species. After a slow start, discussions were again poping up in many directions, out-scaling village boarder. One player from Thaclang developed his idea of a reserve area. It was submitted to others but without positive returns. Crab bank management solution was again mentioned but this time Thaclang village headman was present and he asked advices on the start up of this procedure to his colleague from Klongklud village. The idea to experiment a new crab bank project unified Thaclang villagers and they invited KKB RDSC officer to join a prospecting visit of their village area.

5.4. Logistic perturbations.

Four errors occurred during the workshop. First day, player 15 was not recorded in the software and flag color post-its of player 6 additional gears were given in half pink

instead of full pink. Second day, player 6 gears in fourth year were located in the wrong software area and fifth turn was ran for only eleven months. However, these errors did not cause major disruptions as they did not change systems dynamics (player 6 individual results were corrected and CPUE was the mean value of all months in the turn). If software manipulation can be source of mistakes in ComMod implementations; in this case hast and lack of detachment due to researcher first experience were the main errors' cause. To take time for control model inputs and outputs carefully (personally or with the help of an assistant) should not be too long and appeared essential.

Box 2. Illustration of IdeasFishery game events

1 : gears' localisation on the game board. 2 : players' requesting additional gears at the computer desk. 3 : interview after session. 4 : collective debriefing. 5: public results display.

Table VI. Individual dynamics during the two game sessions. Players' decisions results, to link with their strategies defined table IV. P = Player. Last five players being simulated in game with the same play, they have being group in a common line.

SESSION 1

Player number- gears available	Number of gear located in bay				Number of gear located in sea				Players' catch
	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4	*Year 1 to 4; / distinguishes bay and sea catch when necessary.*
P1 – 4 traps	2	3 +	4 +	6 ++	/	/	/	/	224 – 341 – 301 – 192
P2 – 4 traps	2	4 ++	4	6 ++	/	/	/	/	226 – 462 – 298 – 202
P3 – 4 traps	4	4	6 ++	6	/	/	/	/	451 – 454 – 447 – 194
P4 – 6 traps	6	6	8 ++	8	/	/	/	/	677 – 682 – 596 – 254
P5 – 4 traps	2	4 ++	4	4	/	/	/	/	226 – 454 – 298 – 128
P6 – 3 traps	3	0 ---	0	0	0	3 +++	4 +	5 +	338 – 357 – 320 – 180
P7 – 5 traps	0	0	0	0	3	4 +	5 +	6 +	368 – 476 – 400 – 216
P8 – 5 nets	4	4	4	5 +	1	1	1	2 +	389/96 – 386/88 – 236/56 – 118/49
P9 – 3 nets	2	3 +	3	4 +	/	/	/	/	194 – 290 – 177 – 95
P10 – 4 nets	0	0	0	0	1	4 +++	6 ++	6	98 – 350 – 333 - 148
P(11-15) – 5 nets	/	/	/	/	5x5=25	5x5=25	5x5=25	5x5=25	2450 – 2200 – 1400 - 625
Total: 15P – 67 gears	25	28	32	39	30	37	41	44	5737 – 6540 – 4862 - 2401

SESSION 2

Player number- gears available	Number of gear located in bay					Number of gear located in sea					Players' catch
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year 4	Year 5	*Year 1 to 4; / distinguishes bay and sea catch when necessary.*
P1 – 4 traps	2	3 +	4 +	4	4	/	/	/	/	/	264 – 494 – 646 – 660 – 428
P2 – 4 traps	2	3 +	4 ++	4	4	/	/	/	/	/	266 – 488 – 651 – 661 – 429
P3 – 4 traps	1	1	1	1	1	/	/	/	/	/	132 – 165 – 161 – 165 – 107
P4 – 6 traps	4	4	5 +	6 +	6	/	/	/	/	/	527 – 494 – 807 – 990 – 643
P5 – 4 traps	2	2	2	2	2	/	/	/	/	/	270 – 325 – 323 – 330 – 214
P6 – 3 traps	0	2 ++	2	2	2	2	0 --	0	0	0	255 – 329 – 324 – 332 – 214
P7 – 5 traps	2	0 --	0	0	0	0	2 ++	2	2	2	264 – 315 – 331 – 282 – 139
P8 – 5 nets	4	4	4	4	4	0	0	0	0	0	490 – 617 – 573 – 603 – 462
P9 – 3 nets	2	2	2	1 -	3 ++	/	/	2	1 -	2 +	245 – 309 – 286 – 151 – 346
P10 – 4 nets	0	0	0	0	0	2	2	0	0	/	187 – 239 – 247 – 74 – 240
P(11-15) – 5 nets	/	/	/	/	/	5x5=25	5x5=25	5x5=25	10x5=50 +++++	10x5=50	2350 – 3000 – 3075 – 3700 – 2750
Total: 15P – 67 gears	19	21	24	24	26	29	29	29	53	53	5250 – 6775 – 7424 – 7948 - 5972

Legend: + or - : one gear more or less than previous turn, n : initial maximum gear available number reached, / : fishing zone not available,
≈ or ≋ : one or two additional gears acquired (these actions are all indicated in bay tables for more legibility but players could use them freely).
Both gear types obtaining was open to all players but any requested one different than his other ones.

Table VII. System dynamics during the two game sessions. Unit Effort, CPUE and BSC population density evolution in the two fishing area. Remark: CPUE was not presented directly this way in the game but per months (see annexes 4).
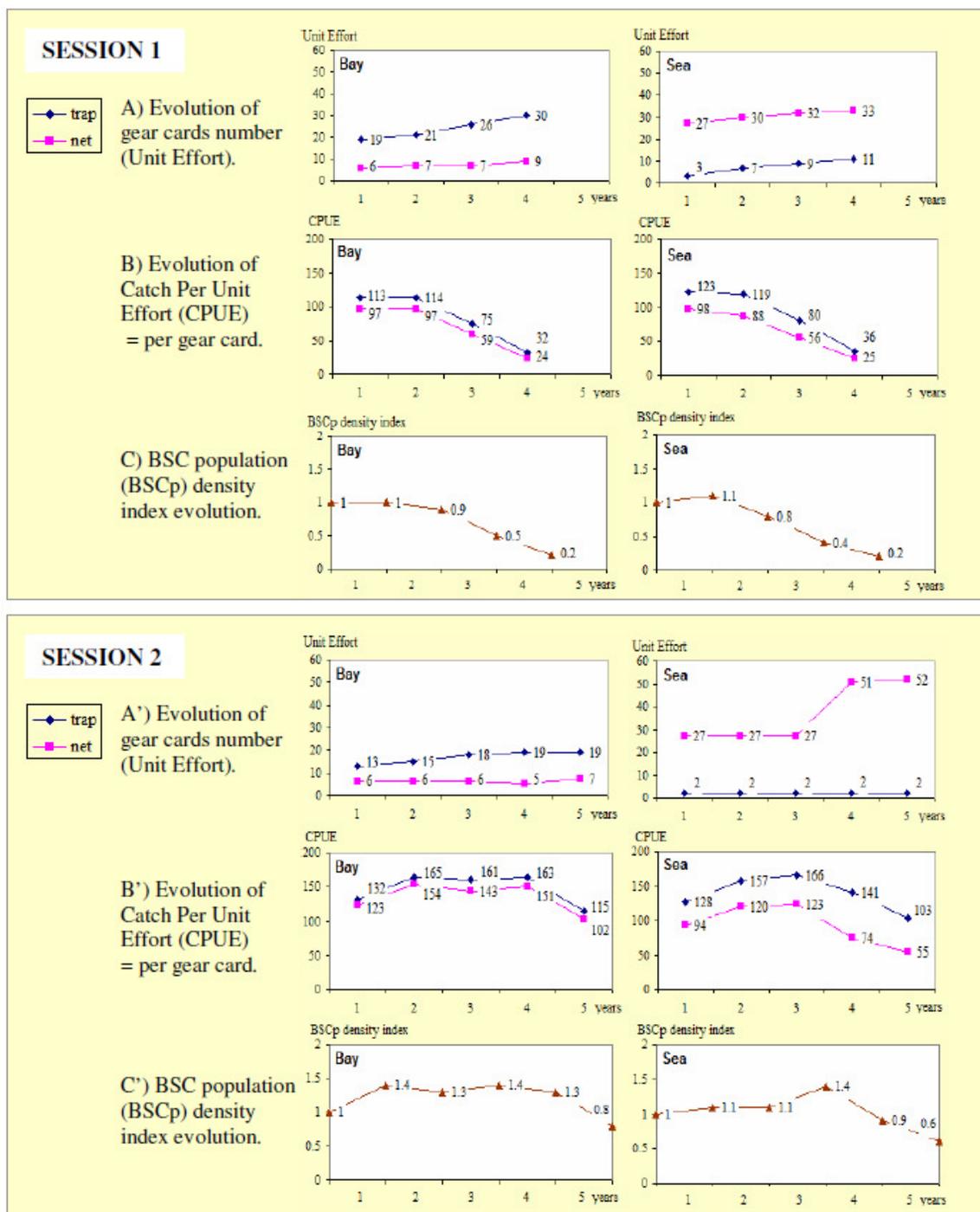
CHAPTER 6. WORKSHOP ANALYSIS:
COMMUNICATION NETWOKS & PARTICIPANTS' FEEDBACKS

More subjective, this chapter completes the workshop description by presenting a synthesis of researchers and stakeholders' perceptions.

6.1. Synthesis of researchers' observations on group exchanges' dynamics.

Communication network analysis focused on three observation points:

➢ <u>Participants' use of the different game spatial areas.</u> As presented chapter 4, figure n, the two villages were separated during the workshop by a line of tables. However, it appeared that despite of constituted an obstacle, it facilitated inter-villages exchanges as villagers took place face to face around them. When open-questions raised, they were then shared inside this global cycle of players rather than inside the village structures. From this organisation, players switched to a disposition per fishing areas by intermixing around the game board. Nevertheless, this practical arrangement did not support specific exchanges. Players seemed to be led by strong individual behaviours and despite researchers' notices to wait everyone decisions, they frequently moved from one step to the other separately. Regarding to public bulletin board area, it was not used by players. Game observers remained back from the game areas.

➢ <u>Players' organisation per profiles.</u> As described above, any strong associations per villages or per fishing areas were observed. Regarding to gear type differentiation, its diversity was represented in village 2 and fishermen sat two by two between colleagues; but the local facilitator marked a discontinuity among net players (figure 6). As discussions between players seemed to be directed by neighborhood relations, an enforcement of exchanges between colleagues using the same gears may have occurred but it was not significant. Gear types topic was not discussed collectively. Though, few comments from individual interviews can be noticed: when player 1 was interrogated on his exchanges with the other village, he mentioned only the two trap user members; player 5 specified her observation of net number increased inside the bay, phenomenon she disapproved; and the two net fishermen as well as their village headmen were the only one to evocate mesh size regulation. Differences in gears' number did not seem to

influence exchanges' directions. Overall, only two partner relationships were clearly noticeable and concerned the oldest participants (P2, P9) which requested support from one of their colleagues (respectively P1, P8).

➢ <u>Structure of exchanges in time.</u> During the workshop, four types of exchanges' times could be distinguished: the game initiations, the plays, the collective debriefings and a set of informal times such as the break intervals, the sessions' interval and the transportation intervals. Separation of the game period was strikingly noticed by confused and collective exchanges during the first years while the rest of the plays were dominated by individual behaviours. Informal intermissions remained mainly out of observations. However, the way back in van on the second day led to multiple exchanges between Miss Kunsook and Thaclang villagers about their feedbacks on this experience.

6.2. Stakeholders' perceptions from individual interviews' analysis.

Appendix 6 presents an analysis of participants' answers to individual game questionnaires. Five elements can be enlightened:

➢ <u>A good transposition by stakeholders of their reality into the game.</u> Players found the game's representation realistic and accepted it, some of them suggesting to add new elements such as boats or specific landscape references. Moreover, the genuine nature of fishermen behaviours was noticed by Miss Kunsook and by our facilitator in Klongklud .

➢ <u>A common recognition of the playful atmosphere and of the exchanges' quality.</u> Conversations were judged easy. Moreover, if the exchanges with other participants were firstly let aside in players' comments; aspects related to communication took more importance the second day and it was their main remembering few weeks after the workshop. Recognition of others and of their thinking came back several times in observations. However, the acknowledgment of a group influence on players decisions during the game remained moderated.

➢ <u>A small increase of conventional knowledge.</u> Scientific learning appeared limited as participants were not curious to question game indicators. Though, it was not our aim and five participants perceived their meeting with others as a source of knowledge.

➢ <u>A slight approval of its usefulness.</u> All participants found the workshop useful to stimulate thinking and common recognition of individual representations. However, they remained divided on its impact in reality, notably to promote cooperation.

➢ A keen interest for a little while. The workshop ended with renewed discussions of several projects such as the crab bank experimentation in Thaclang and the setting up of its management group, or the use of individual baskets as personal crab banks in Klongklud. The two following weeks, participants continued to discuss about these intentions and their experience; mainly with their close relatives. However, after one month and a half, no concrete projects had emerged and discussions seemed closed.

CHAPTER 7.   DISCUSSION

7.1. Contributions of this experience in the development context of KKB.

The participatory gaming and simulation workshops are the key components of the ComMod approach. They refer to what has been recently popularized as serious games. Certainly KKB role playing game primary purpose was not pure entertainment, but to what extent did it effectively stimulate the reflections on BSC fishery management? Ability to make theirs the game and its stakes depends of how participants relate them to their reality and behave during the gaming sessions accordingly. On this point, it seemed that participants easily transposed their representations into the game, which allowed discussions on concrete facts while the game itself was just a simulacrum. However, the observation and analysis of how participants' interacted with and through the game belongs to social sciences. Its discussion is limited by our inexperience on conflicts management, grasping of game/reality representations… Nevertheless, several observations can be discussed.

➢ Creation of a new link between stakeholders as players of a common game. A striking observation is the important change in players' behaviour during the game. Indeed, it seemed that behaviours observed in games were either individual behaviours directly linked to fishermen reality, or 'group of players' behaviour apart from their reality (first turn confusions). This ability of the game to create a common status among players and to unhinge participants in their discovery of a new shared representation of their system is interesting. However, the initial arenas of discussion observed during the first stage of the gaming sessions were not re-opened during the latter stages. This observation suggests that if players effectively embraced their reality into the game, it

remained difficult for them to balance between both frameworks during this first exercise. As 'group of fishermen' seemed an ungrounded concept in participants' reality, it did not take over from the 'group of players' concept introduced in the game. It confirmed that collective reflection on the system is not usual for participants and it can explain that the public bulletin board domain remained un-used. Though, the re-forming of the 'group of players' during the initialization stage of the second day of the workshop suggests that it is a spontaneous tendency which could be developed.

➢ <u>A starting point to nurture future participatory processes.</u> The aim of this experience was not to find management solutions, but rather to initiate participants to a new approach to grasp their environment and their role in its management. These processes take time and are generally included in wider spheres of management. Impacts are then difficult to evaluate, especially, in a short term project as this one. If participants remained divided on the project impacts in reality; they all appreciated the experience and they attached importance to the recognition of others: first steps to any collaborative projects. By being sensitive to the concerns of fishermen as well as the other organizations (management center, represented by KKB RDSC officer, and research center, represented by Miss Kunsook), the group enhance its trust building capacity (Hahn et al. 2006).

➢ <u>A methodology to trigger deeper involvement of local stakeholders.</u> By putting players in action, in the decision process and physically, games offer them to participate and to contribute to the modeling process. Moreover, debriefings request them a reflective analysis of their behaviours in the game and in reality. This fosters their active involvement into the workshop and contributes to a better appropriation by participants of the model stakes. This social learning process (Pahl-wost *et al.*, 2004) drives the group capacity to generate new knowledge. Indeed, in this project, participants broadened the game representation by themselves by evocating other actors. Their wishes to invite them to play and the apparition of testing behaviours (by P9, P10 in the second gaming session and later on by P6, P8 in their suggestions to improve the game (see appendix 3 and 5)) shown their ability to take over the game possibilities. Thus, the workshop offered to participants the possibility to take initiatives: for instance, to build a project of crab bank in Thaclang and to set up its management group with a designated leader among the villagers Even if those are not concretised, the process to express them collectively already reinforces stakeholders' self-organisation ability.

It was enlighten by Hahn et al. (2006) that trust building and knowledge generation are the central components to collaboration. These lead to increase the local legitimacy for ecosystem management and to facilitate the identification and creation of win–win situations and conflict resolution.

7.2. Re-assessing the model after its use in the workshop

To design a simulation model imposes to take positions on parameters' choice, value and presentation. Analysing these choices a posteriori in light of participants' reactions is very interesting. Two sensitive points are enlighten below: the representation in the game of an information that is not accessible in reality (the BSC subpopulation density), and the removal of another one which exists in reality but was not included in the game (the crab bank tool).

➢ Inclusion of BSC subpopulations density. BSC subpopulation density was an unusual information as it is not a data that can be directly measured in reality. Its availability during the gaming sessions induced perplexity among the players, as reflected by the doubt about their objective they expressed on the second day: 'the aim of this new game is it to increase the BSC subpopulations' density?' This question revealed the gap that can still exist between their understanding and perception of conservation stakes and their interests. Moreover, it led to a common awareness and recognition of the key question in management: the balance between biological and social dynamics.

➢ Non-inclusion of crab bank tool. Crab bank management solution was frequently mentioned by local stakeholders in our preliminary interviews, and a prototype was recently started in Klongklud village. However, mechanisms and efficiency of crab banks are not assessed yet; and it could be noticed that Klongklud prototype remained not used. Thus, we decided not to include it in the game to let stakeholders co-construct their representations from a free baseline, without imposing any options. Crab bank subject was over-present in participants' discussions during the workshop. Though, they did not all introduce it similarly. It was first only cited by Klongklud villagers individually while it was then taken up by Thaclang villagers who reached an agreement on promoting the idea of a future project of implementation. Its absence from the game also allowed other ideas to emerge, such as the setting up of a reserve area. In an objective of community-based resource management, management tools should be discussed collectively. Their

absence from the game, even if some are existing in reality, invites the participants to clarify and justify collectively their opinions on these elements and by this way to share a common understanding that can be later on referred to in case the players request to finally include a particular element. The collective decision to include a new element in the game and the discussions needed to specify how to concretely do it represent one way to involve the participants of a participatory simulation workshop in the design of the model. Thus the modelling process becomes a co-modelling process. As a result, participants gain a sense of ownership of the model, which progressively evolves as a shared and well accepted representation of the socio-ecosystem, paving the way toward its collective management.

7.3. Collaboration between system expert and ComMod designers.

➢ <u>Impacts on the project development.</u> A preliminary diagnosis of the socio-ecosystem is essential to understand its stakes and to be able to take the context into account while implementing a participatory process like ComMod. Often, ComMod approaches have been designed and implemented by a researcher who was also the one achieving the diagnosis and providing its scientific expertise. In our case, the roles of scientific expert and approach designer were hold by different partners; which led to different relations with local stakeholders. The previous involvement of the researcher and the expectations that 'researchers know' can bias the communication with local stakeholders. My particular status as a young and foreign student probably conveyed an apparent neutrality. Stakeholders naturally wished to explain me their situation, which led them to explicit their representations. However, ComMod approaches cannot be hold by an external designer alone; especially when the designer cannot speak the local language and when the project lasts only few months. My collaboration with Miss Kunsook gave more significance and legitimacy to the workshop. Her expert knowledge of the study site and her good relationships with several local stakeholders allowed a fast and smooth introduction of the project, in a climate of confidence. The co-construction of the first version of the model, involving the scientific expert and the external designer, also contributed to strengthen the collaboration and to effectively share knowledge, enhancing our both representations. Finally, these two roles (scientific expert of the system and

ComMod process designer) request specific aptitudes and engagements, which enlighten the pertinence of collaborations.

➢ Interest in term of approach transmission. A current question raised by researchers on the development of ComMod approach is how to transfer it. Its learning by its practice is a usual method but it requests a close supervision. This project beneficiated from a local collaboration with post-PhD students who just finished similar projects and who could thus perform a form of tutoring under a global supervision by my CIRAD advisor.

CONCLUSION: TOWARD A PROFESSIONALISATION?

This project led to the implementation of a participatory simulation workshop to initiate a companion modeling process in the context of KKB BSC fishery management. The experience was rewarding but then the question by the end is: will there be any follow-up? In this project, we aimed to set a precedent to unhinge participants' representations and to nurture future participatory works, which concrete development will depend on the ability of local stakeholders (including resources' users, local managers and researchers) to self-organize. The transfer of the ComMod approach toward local partners is a key to ensure that a process just started will induce more than just a sensitization of the stakeholders to the issues at stake. How to teach and disseminate such an adaptive approach? Thirteen years of researches have led to the consolidation of methodological aspects, with the production of application guidelines, an ethic charter and a set of different tools. However, can it be a professional tool? Natural resource managers are interested to take over the method, but its cost in terms of training autonomous agents is still too high for both trainees and trainers sides. Is it possible to train autonomous agents quickly and efficiently? Many questions remained and open the field to new researches and pilot projects.

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LIST OF ABBREVIATIONS

ABM   Agent Based Model
BSC   Blue Swimming Crab (*portunus pelagicus*)
FAO   Food and Agriculture Organization
KKB   Kung Krabaen Bay
NRCT   National Research Council of Thailand
RDSC   Royal Development Study Center
SES   Socio-Ecological Systems

LIST OF FIGURES, TABLES, BOXES, APPENDIXES

APPENDIX 1: Questionnaire used during the second field trip.

My personal notes are indicated in italic. Questionnaire was translated in Thai and interviews were conducted by Miss Kunsook. This baseline frame addressed to fishermen was adapted to interview village headmen, prey shop and BSC market' owners.

1. Questions regarding to the set up of the game:
- Are you fishing all the year the same way? Why?
- What is your activity during the dry season and during the wet season?
- How many days did you went harvest crab last week?
- How many day will you go harvest crab next months (May)?
(Spontaneous timing separation? Representation in days, weeks, months, seasons, representation in the past, future)
- Can you describe me what are you usually harvesting in your gear?
- How much bleu swimming crab can you harvest in one day? In one week?
- It is the same amount each time? How can you explain the differences?
- What is the size of the crab that you catch? (picture)
- How many females can you harvest? How many of them bear eggs?
(Timing references / description: number, kg, tonne, cm, small, medium, big, juvenile, mature, sex, bearing-eggs…)

2. Questions regarding to the market: *(definition of all the actors, importance, influence, I still wonder if I should include it in the game…)*
- What do you do with the blue swimming crab that you have harvested?
- Where are you selling them?
- How much can you earn by selling them?

3. Questions of relationship in the group: *(position in the group, interest and involvement, social system representation)*
- How many fishermen who harvest blue swimming crab do you know?
- Are you usually see other fishermen when you are harvesting?
- How many fishermen do you think harvest blue swimming crab in the area?
- Are you talking about blue swimming crab fishery with other peoples? Who?
- Is that interest you to talk about blue swimming crab fishery? Why?
- Would you like to participate in a game about crab fishery? With who would you like to play?

4. Questions free expression: *(see what seems important to them, system evolution, representation in long time past/ future, talkativity)*
- What is your best memory as fishermen?
- When and how did you start harvesting crab?
- Would you like that your children continuous to harvest blue swimming crab after you? Why?

5. Can you write for me:
(can read, write and fill up a form with simple questions, are familiar with number of gear they use and their mesh size)
Your name: Your village name:
The kind of gear that you use:
The number of gear that you use:
The mesh size of your gear (picture):
Can you make a cross in the good answer: are you going to fish?
□ inside the bay □ outside the bay □ both inside and outside the bay

APPENDIX 2: Details of the KKB conceptual sub-model processes

Biological module: The BSC subpopulations' dynamic is controlled by four processes: the growth, the natural mortality, the reproduction and the migration.

Growth: BSC subpopulations are structured by an ordered collection of crabs' numbers per age classes: from 1 to 36 month-old age classes. The growth is then represented in the simulation by the following sequences:

> **Model sequences of the BSC subpopulations' growth process:**
> *(Bold prints represent model variables)* At each time step (month):
> - Individuals from each **age classes** are moved to the next class.
> - The first age class stay empty until the arriving of new recruits.
> - Last age class accumulate effectives.

Natural mortality: Natural mortality represents in our model all auxiliary mortality causes to the fishing mortality. Its process is represented by the below sequences:

> **Model sequences of the BSC subpopulations' natural mortality process:**
> *(Bold prints represent model variables)* At each time step (month):
> - The **natural mortality rate** is apply to all groups within all sex and age' classes
> - Last age class effective is then divided per 10 to accentuate death of old age.
> - Natural death number is store.

Reproduction: BSC subpopulations' reproduction is characterized by a density-dependence and a shared recruitment among the two habitats. Its process is represented by the following sequences:

> **Model sequences of BSC subpopulations' reproduction process:**
> *(Bold prints represent model variables)* At each time step (month):
>   - A number of recruit is calculated in each habitat by the following sequences:
>   For each BSC females' subpopulations:
>   - The number of mature females is calculated from the **maturity age**.
>   - The number of ovigerous females is calculated depending on the **monthly reproduction rate**.
>   - The number of recruit per ovigerous females is calculated from the females' **fertility**, parameter dependent of the subpopulation **density** itself related to the habitat **carrying capacity**.
>   Finally, all these data are associated to calculate the total recruit number.
>   - Then, each habitat' male & female BSC subpopulations' first age classes are update with the 'total recruit number / number of habitat' and in relation with the **sex ratio**.
>   - Finally, s' size and density are updated.

Migration: BSC subpopulations' migration is controlled by the following sequences:

> **Model sequences of BSC subpopulations' migration process:**
> *(Bold prints represent model variables)* At each time step (month):
>   For each BSC subpopulations entities:
>   - A collection of mobile crabs' numbers per age classes is calculated from the same **migration rate** parameter.
>   - These collections are subtracted to the BSC population of their original habitat,
>   - And added to the BSC subpopulation of the second habitat.

Social module: The social module is controlled by three processes: the location by fishermen of their fishing gears, the BSC catch by these ones and the data exportation.

Fishing gears' location: Gears' location is controlled by the following sequences:

> **Model sequences of fishermen' gears location process:**
> *(Bold prints represent model variables)* At each time step (month):
>   Each fisherman:
>   - Get back his previous fishing gears from their **location**.
>   - Receive his **decisions** as a collection of fishing zones associated to a number of fishing gear entities.
>   - localise them accordingly.

BSC catch: The catch process is marked by a change in time step. Catches are simulated for one day according to fishermen decisions, while their daily catches' results are multiply by 31 to take into account monthly catches' impacts.

> **Model sequences of fishing' gears catch process:**
> *(Bold prints represent model variables)* At each time step (month):
>   Each fishing gear:
>   - Calculate the number of female and male crabs that it will potentially catch from his **catchability** * the corresponding BSC subpopulation **density** (regarding to sex and location).
>   - Then, for each one of these potential catches:
>   - It selects, in the corresponding BSC population, a crab number randomly from 1 to the population' size (model auxiliary variable).
>   - It scans the different effective of each age class of this population to find from which one its crab depend.
>   - If this crab age class is superior to its **selectivity**: plus 1 is added in the corresponding age class of its corresponding female or male **catch bag**; while minus 31 is subtracted to the population corresponding age class of the target.

APPENDIX 3: Details of players' strategies during the two game sessions.

Summary of players' strategies in gear allocation during the two game sessions. Data were recorded from players' individual interviews after each session; remaining them their decisions as presented table III. nP: n number of players, Pn: player id number n.

SESSION 1		SESSION 2	
Year	Players' strategies in gear allocation	Year	Players' strategies in gear allocation
1	*A wild range of gear number were used:* 5P where not sure to understand all rules: - 4P put a small number of gears to test the game carefully (P1, P2, P7, P10), - P6 which had only 3 nets used them all but also justified it by a test. 5P referred to reality: - 3P used their maximum, explaining that it is no need to keep some home or expressing their wish to reach a high production (P3, P4, P8), - 2P used only an average number related to a reflection on their needs (P5, P9).	1	*All used less gear than their maximum:* *In village 1,* 4P evocated personal thinking related to labour, maintenance and production needed (P1, P2, P4, P5), P3 kept just one evocated conservation issue *In village 2,* 3P evocated an agreement (P8, P9, P10): P8 specified about 1 or 2 gears less, P10 specified to maintain crab population 2P expressed the wish to test the game today (P6, P7).
2, 3, 4	*All players reacted to BSC population decline by increasing their gear number to maintain their production. However, two main strategies can be distinguish:* 5P clearly used as much gear as possible, buying new ones when it was possible (P1, P2, P3, P4, P10), 5P adopted a more progressive increase, considering carefully their choices by evocating gear maintenance, own needs… (P5, P6, P7, P8, P9) Among all, 6P clearly refer to reality in their justifications (P1, P5, P6, P8, P9, P10). Only P5 did not request additional gears and justified it by the fact that she has another lucrative activity.	2, 3, 4, 5	*Strategies were diversified:* 5P keep their initial low number all game: - 2P after the first concession were satisfied of their catch (P6, P8). - 3P remain concerned by conservation thinking (P3, P5, P7). 2P kept their low number but adapted it by testing if possible to decrease it again while keeping same production (P9, P10) P4 kept is low number first, joining previous conservation agreement, but increased it then when BSC population raised, for budget management. 2P increased their gear number to get higher production (P1, P2). Among all, 4P clearly refer to reality in their justifications (P1, P2, P4, P5). Any players bought new gears. The 3rd village doubles this fishing pressure in 4th year but any players shown reactions.

APPENDIX 4: Evolution of the all game public catch indicators.

Public catch indicators' (calculated on the total catches) evolution during the first game session

SESSION 1

For Traps   For Nets

Public catch indicators' (calculated on the total catches) evolution during the second game session
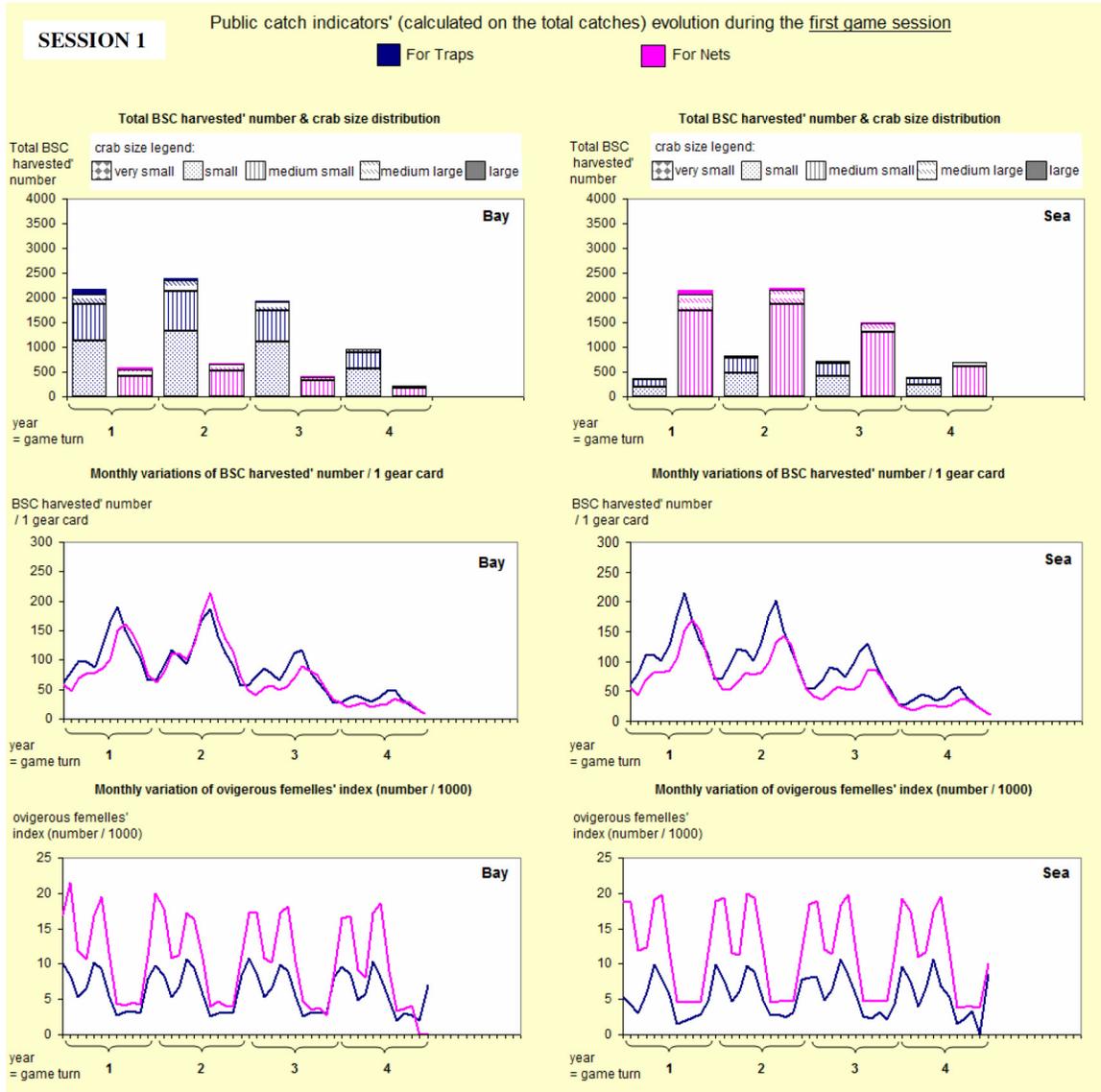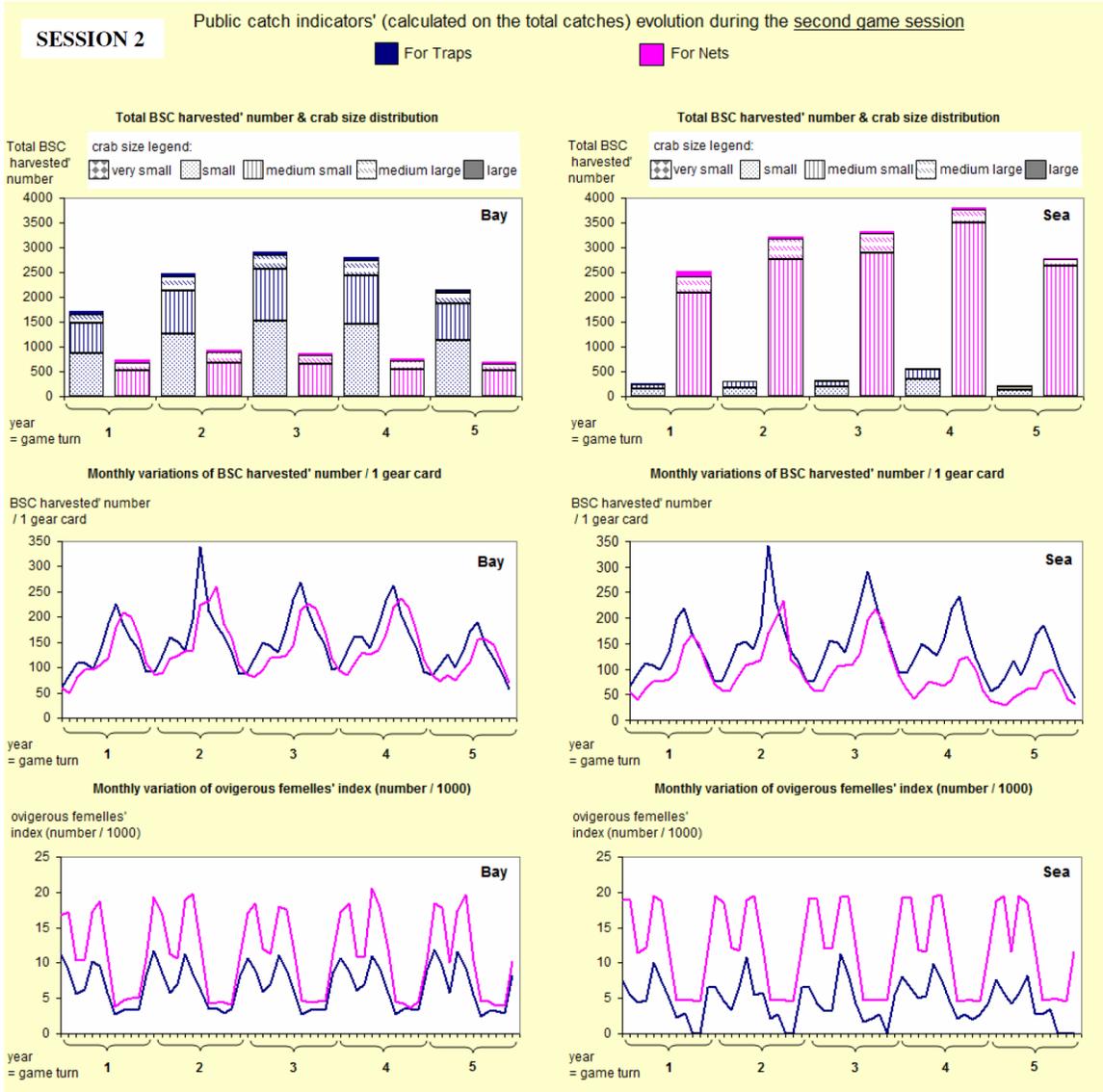
APPENDIX 5: Game questionnaires.

I. First part: report of the first afternoon: *(Individual interview after the first day workshop before players leave = 2 interviews/ researcher).*

1. General evaluation of the game.

a) Did you like playing this game? Why?

b) Do you find the game session period: □ *too long*   □ *ok*   □ *too short* , why?

c) Were there elements that were not very easy to understand? Which ones?

d) Do you think the game was realistic? Why?

e) What did you find the most realistic?

f) What did you find the less realistic?

g) Do you have ideas of elements that could be added in the game to make it more realistic?

2. Your role and decisions in this afternoon session.

a) Year by year, can you justify your decisions' choices?

Year	Trap no.	Net no.	Why?
1			
2			
3			
4			

b) During the game, did you pay attention of what the other players were doing?

c) Were you surprised by some of their actions? If yes, give examples.

d) Did the actions of other players influence your choices? If yes, who? Why?

e) Did the staff members (researchers and observers) help you to make your choice? If yes, how?

g) Any other comments?

II. Second part: report of the second afternoon: *(Individual interview after the second day workshop before players leave = 2 interviews/ researcher).*

1. General evaluation of game:

a) Did you like to play this second game? Why?

b) Did you find the game easier to understand today than yesterday? Why?

2. Your role and decisions in this afternoon session:

a) Year by year, can you justify your decisions' choices?

Year	Trap no.	Net no.	Why?
1			
2			
3			
4			
5			

Today, discussions between players were encouraged.

b) Did you find easy to discuss with the others?

c) Are these discussions helped you to better understand decisions and actions of the other players? Please specify if you have examples…

d) Did these discussions influence your choices? Why?

e) Did the staff members (researchers and observers) help you to make your choice? If yes, how?

f) Other comments on this games session?

3. Evaluation of player interest in the field workshop

a)   What were your motivations to participate in the workshop for the first afternoon?

□ *per curiosity* □ *to help researchers* □ *to learn new knowledge*

□ *to meet other participants* □ *other, please specify:*

b)   What was your motivation to come back and participate in the workshop the second day?

□ *per curiosity* □ *to help researchers* □ *to learn new knowledge* □ *to meet other participants*

□ *the compensation* □ *other, please specify:*

c)   What do you think about these 2 days workshop in general?

d) Do you think it is useful? Why?

e)   What did you find the most interesting?

4. Evaluation of effects on individual perceptions:

a) Did you learn <u>something new</u> during this workshop about the following subjects?

Please specify from whom (researchers, participant from your village, from the other village).

- about the BSC population characteristics and movements:

- about the impacts of fishing on the resource:

- about other fishermen in KKB area:

- anything else?

b) Do you have new questions after playing the game? If yes, please specify.

5. Evaluation of effects on collective perceptions:

a) Among participants of this workshop, who did you know before? Please specify the names.

b) Did you exchange with the following peoples,

about what? did you find it interesting? and why?:

- other players from your village?

- other players from the other village?

- the head of your village?

- the head of the second village?

- the researchers' team?

- the representant of KKB (Pi Solanan)?

c) Did the game change your way of thinking regarding your relationship with other fishermen?

If yes, please specify how?

d) Was it easier to discuss with other participant in the game than in reality? Why?

6. Evaluation of the potential of the field workshop to facilitate cooperation

a) The idea cooperation of among stakeholders has been discussed during the game.

Do you think that cooperation is an important factor for management? Why?

If yes, do you think that all fishermen would agree to cooperate?

What would be the difficulties of this cooperation?

b) Do you think that the game could facilitate this cooperation? Why?

7. Conclusion, Evaluation of interest for future projects.

a) Do you have any suggestions to improve the game?

b) Would you like to play again? With who? and why?

8. Other comments?

III. Third part: *(part by phone 1 week later)*

a) Did you continue to think about the workshop after the research team went back to Bangkok?

If yes, please specify on which subjects and write your new comments.

b) During this week, if you continue to discuss about the workshop with other people can you

please specify: *With who:* the name of the person, his village, if it is someone who participate to

the workshop or not; *The contents of the discussion:* what did you discuss, how this person

responded, your comments.

c) What is the most interesting thing that you remember from this workshop?

d) Would you like to continue this work? How?

APPENDIX 6: Game questionnaires' analysis.

Elements of answers reorganised (the complete list of questions is available appendix 5).

Pn: player id number n, vhn: village n headman, KKBo: KKB RDSC officer, CK: Chutapa Kunsook. Players' answers are classified per frequency of occurrence and players concerned are indicated under brackets.

<table>
<tr><td colspan="2" style="background:yellow">Perception of the game</td></tr>
<tr><td colspan="2">

All participants found the time session adapted to their availability.
All found the game relatively easy to understand after the first turn.

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Perception of the game

All participants found the time session adapted to their availability.
All found the game relatively easy to understand after the first turn.

Element most realists:

Players:
size indicator (P8, P9, P7, P4, P3)
gear types (P8, P9, P4, P5)
decline of BSC subpopulations (P2, P8)
monthly variation, peak of production (P10, P4)
to 'harvest' on the game board (P1)
buying of new gear possibility (P6)
ovigerous females' indicator (P7)
fishermen behaviours (P5)

Element less realists:

Players:
There are more uncertainties in catch results and dynamic of BSC density (P6, P7, P8, P10)
Miss external factors such as weather (P9)
Don't know (P1, P2, P3, P4)
Gear cards representation without specify the
       [real gear number' correspondence (P5)

Improvements – day 1 or 2:

Players:
Add crab banks (P4, P3, P5)
+ crab bank manager/ policy (P1)
Add mesh size regulation (P8, P9)
Conservation tools (P7)
Add the boats (P5)
Notice specific landscape (P1, P5)
Season distinction (P7)
Play with 'real value' (P1)
Nothing (P2)

vh1: Add conservation tool as crab bank.
vh2: Add mesh size regulation.
KKBo: Add trawls offshore, and additional factors such as season effect, water temperature, shrimp farm influence…

Future use – day 2:

Players:
Play again and invite:
- other villages - Chaolao village and a fourth one of the area (P1, P3, P5, P8, P9, P10)
- other fishery types (P1),
 + keep BSC fishermen (P7),
 + keep trap fishery (P2)
Others did not specify.

KKBo: to invite other fishery types. To experiment a crab bank in Thaclang.
CK: Plan to continue to work in the area. She is interested to follow and help a future crab bank project.

Future use – 1 or 2 weeks later:

Players:
Play again and invite:
- other villages, village headmen, KKBo (P1, P2, P4, P6, P7)
- deeper water fishery (P9)

Add:
- Crab bank (P2, P4, P8, P10)
+ test its effect (P8),
- Test effect of ovigerous female decline (P6).
- Conservation area (P7)
- Insert KKBo role

Learning aspects

On BSC population characteristics and movements:

Players:
All knew already, despite P4: learn from researchers but could not specify.

vh2: should preserve small crabs, no need to use them.

On impacts of fishery on the resource:

Players:
All knew already, despite P5: learn from graphics of the second day. P6: learn from researchers but could not specify.

vh1: yes, BSC population decline is due to fishing gears utilisation.
KKBo: effect of others fisheries.

On other fishermen:

Players:
Most declared to know already,
Four noticed their meeting with new fishermen (P10, P1, P3, P5).

vh1: learn about the idea of reserve area from Thaclang village. Disagree with the idea that budget is not the most important: it is essential.

Anything else?

Players:
P3: have learn about crab bank management.

vh2: research should continue in the area such as about crab bank and season characteristics.
KKBo: have to work with the consumers also and we could use the law to ban fishery of small crab.
CK: system complexity, stimulate participants' reflections.

Communication aspect

Game exchanges:

Players:
- ***Did you find exchanges easy?***
Yes, not specify (P5,P6,P7,P8)
Yes, closeness (P1, P10)
Yes, have met before (P2, P4)
Yes, share same occupation (P3)
Depend with whom (P9)

Yes, easier than in reality (P3), due to researcher support (P9), but an agreement may be more difficult in reality (P4, P5, P10), because in the game we are a small number of player (P1).
Yes, similarly as in reality (P2, P8)
It is easier in reality: because we have more choices (P7), we can better convince (P6).

Play all together: unbelievable! (P8)

External influences:

Players:
- ***Interest for others' play, day 1***:
No (P8, P9, P7, P1, P4, P3)
For gear location (P6, P2, P5)
For players' id (P10)
- ***Influence of others' play, day 1:***
All no.

- ***Interest for discussions, day 2:***
All yes:
Number of gears and their location (P8, P7, P6, P5)
Collective management (P3, P10)
Help to play (P2, P4)
To know others opinion (P9)
Can observed different results (P1)
- ***Influence of discussions, day 2:***
Yes: 'democratic agreement' (P9), common comprehension (P4, P8), to avoid competition (P6).
Just by one other player (P2,P3/P5)
No (P1, P7)
Just first turn (P10)

- ***Researcher influence:*** All: just to make us think, explain rules.

A possible cooperation?

Players:
All yes, all recognised that it is an important factor for management.

- ***Limitations?***
Have to explain to everybody before (P6, P7)
High number of group involved, their lack of unity (P1, P4, P5)
Selfish behaviours (P3, P8, P9)
Lack of help (P8)
Miss a leader (P1)
Others did not know.

- Does the game can help?
Yes, improve relationship (P2, P9, P6, P1, P4)
Yes, it gives knowledge (P7)
Maybe (P8, P10, P5, P3)

Feedback on workshop experience

Did they like it? All yes:

Players day 1:
lot of information (P6, P3, P10, P4, P1)
fun (P2, P8, P10, P5)
realistic (P9, P1)
'it's our career' (P7)
meeting with others (P5)

Players day 2:
fun (P8, P9, P10, P2, P1, P4)
easier the second day (P7, P6, P2, P1)
exchanges with others (P4, P5, P6)
useful (P3, P10)
similarity to reality (P8)
BSC population dynamic (P3, P7, P4)
could learn (P7)
mediation between conflicts (P9)

vh1: Recognition of the group in a good feeling atmosphere. Reflects feelings of the community.
vh2: Show fishermen concepts and reflections about conservation. Relation fishing pressure and BSC population density.
KKBo: Big picture of the all ecosystem, many factors included, show fishermen thinking, simulate reality into the game, good methodology: not boring.

Did they find it useful? All yes:

Players:
to promote common learning, exchanges, cooperation (P6, P7, P8, P9)
to learn (P2, P4)
to know possible management (P3, P10)
this experience can be use in reality (P4)

vh1: number of traps have decline in the game, discussion about crab bank, would like to continue with more villages.
vh2: this experience can be use in reality.
KKBo: show our recognition for local stakeholders thinking and activate their reflections. Give ideas to think about the situation.
CK: this experience can be used as a reference to continue collective work. Contributed to activate stakeholders thinking and increased their recognition of the problem. It provided better understanding of others' situation for local fishermen. vh2 seemed very interested and discussed a crab bank implementation project with vh1. Moreover, he invited KKBo and P10, P6, P7 to visit the village area to find a place where to implement this future project.

Experience spreading after 1 or 2 weeks?

Players:
- With who did you discuss / about what?
P1: P4, P5, wife, friend / crab bank in the second village, cooperation
P2: P4, P5, wife, daughter, wife / crab bank, budget, conservation area
P3: P2, P5, wife / cooperation with KKBo, personal basket as crab bank (he already has one)
P4: P5, P2 / personal basket as crab bank in front of their house (P2 agreed)
P5: P4, friend / cooperation with researchers, unity of villages for conservation
P6: P7, cousin / decline of the BSC, crab bank, need a leader
P7: P6, wife, cousin / conservation, play with other villages, crab bank
P8: husband, cousin / crab bank
P9: P10 (daughter), husband, son / crab bank
P10: / think about his experience, crab bank, meeting with KKBo

- What is the most interesting thing that you remember from this workshop?
To play with others: gear types, villagers, village headmen, KKBo (P1, P3, P6, P7, P8, P9)
Simulate reality (P2, P3, P10)
Opportunity to talk and be listen (P7)
To talk with others about conservation (P3)
To see gears concentration in the bay (P5)

ABSTRACT

In the actual paradigm of sustainable development, both practitioners and researchers have stressed the importance of including local stakeholders in renewable resource management. This project presents the results of a participatory process implemented using the Companion Modelling approach (ComMod). It aims to promote communication between researchers, managers and fishermen of Kung Krabaen Bay blue swimming crab (*portunus pelagicus*) fishery in Thailand. A two days workshop was organised with twenty-two participants and was based on a computer-assisted role playing game that allowed simulating the fishery. The experience created new links between participants, contributed to build trust among local stakeholders and researchers, and stimulated social learning. Moving further toward setting-up community-based management will depend on the willingness and the ability of the local stakeholders to self-organize. This project also allowed a reflexive analysis of the collaboration between expert scientists and ComMod designers.

Key words: companion modeling (ComMod), participatory approach, renewable resource management, agent-based model (ABM), role playing game, fishery, *portunus pelagicus*, Gulf of Thailand.

RESUME

Dans le paradigme actuel du développement durable, les gestionnaires et chercheurs ont souligné l'importance d'inclure les acteurs locaux dans la gestion des ressources renouvelables. Ce projet présente les résultats de la mise en œuvre d'une démarche participative par l'approche de modélisation d'accompagnement (ComMod). L'objectif était de promouvoir la communication entre les chercheurs, les gestionnaires et les pêcheurs de la pêcherie de crabes bleus (*portunus pelagicus*) de Kung Krabaen Bay en Thaïlande. Un atelier de deux jours a été organisé avec vingt-deux participants et s'est déroulé autour d'un jeu de rôles basé sur un simulateur informatique représentant la pêcherie. L'expérience a permis aux participants de tisser des liens; et a contribué à construire une plateforme de communication propice à l'établissement de relations de confiance et à l'apprentissage collectif. Le relais est passé aux acteurs locaux, la poursuite de la dynamique enclenchée dépendra de leur capacité à s'auto-organiser. Ce projet a aussi permis une analyse réflexive du travail de collaboration entre un expert scientifique et un animateur de démarche participative.

Mots clés : modélisation d'accompagnement (ComMod), approche participative, gestion des ressources renouvelables, système multi-agent (SMA), jeu de rôles, pêcherie, *portunus pelagicus*, Golfe de Thaïlande.