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Final report

project	**Assessing economic and welfare values of fish in the Lower Mekong Basin**
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Contents

1 Acknowledgment

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2 Executive summary

The project “Assessing economic and welfare values of fish in the Lower Mekong Basin”, completed in July 2016, focussed on the valuation of fish in rural livelihoods, with Cambodia as a case study of the Mekong Basin.
The main objectives of the project were to i) assess the relative contribution of fisheries to welfare, with a focus on poor and vulnerable social groups, and ii) identify strategies that increase the welfare and livelihood value of fish.
Partners were WorldFish, the Inland Fisheries Research and Development Institute (IFReDI, Cambodia), the Cambodian Agricultural Research and Development Institute (CARDI), the Royal University of Phnom Penh (Cambodia), Can Tho University (Vietnam), and Ubon Ratchathani University (Thailand).

The project developed a new methodology (“welfare assessment”) combining quantitative economic surveys and qualitative open discussions. The approach covers income, nutrition, labour, health, and resilience. It resulted in a detailed, multifactor and nuanced assessment of the various and relative roles of fish in rural livelihoods.
The project also produced:

- an estimate, for the first time in Cambodia, of the price of one tonne of fish at first sale (weighted average based on catch composition integrating geographic and seasonal variability), and its value added along the trade chain.
- an updated assessment of the fish production in Cambodia, based on the productivity and extent of various aquatic habitats, including vast habitats previously overlooked (e.g. flooded shrub land).
- an estimate of the actual economic value of fish in Cambodia.

The project outputs include:

- two databases (one year of fish price monitoring, and three years of livelihood surveys throughout Cambodia), already shared with UNDP and Conservation International for further analyses.
- four peer-reviewed publications (on fish and nutrition, fish resources in Cambodia, digital surveys in developing countries, and representations of rural livelihoods in occupational questionnaires).
- nine published reports on i) Fish production (fish productivity by habitat; aquaculture production in Cambodia; methodology for standardized fish monitoring in the Mekong Basin); ii) Nutrition (nutritional and health value of fish); iii) Socioeconomics (economic value of fish in Cambodia; role and value of fish in the welfare of rural communities); and iv) Livelihoods (adaptation to environmental change; trends, opportunities and constraints in the contribution of fish to the welfare of rural communities in Cambodia).
- four science articles (on pathways for fisheries-related information in Cambodia, Cambodia's fisheries during the last decade, fisheries in the Mekong Basin, and an overview of the roles of fish in welfare in Cambodia).

Most of these documents are available on the project Facebook page: www.facebook.com/MekongFishValue. The project also contributed to a 52 min long TV documentary (“The secret life of lakes – Tonle Sap”) broadcasted on national channels in Cambodia, France, Germany and Canada.

To date, project findings and recommendations have been presented at five international conferences, in three national TV news programs, seven online news reports and three paper media articles. Results have also been presented at the Cambodian Association of Parliamentarians for Population and Development (CAPPD) of the National Assembly, and the interactions with parliamentarians will extend beyond the project end. Several additional outputs remain available for further development and dissemination.

3 Background

Fish is an essential component of food security in the Lower Mekong Basin (47% to 80% of the animal protein consumed in the four riparian countries originate from freshwater fish; Hortle 2007), but capture fisheries also provide income, jobs and livelihood opportunities on a large scale (FAO and WorldFish Center 2008). In Cambodia alone, the fisheries sector provides full-time and part-time work to around 2 million people (RGC 2010).
Despite this, the importance of inland fisheries as an ecosystem service and as a central element in rural livelihoods remains poorly recognized (UNEP 2010). Assessments of Mekong fisheries macroeconomic figures are limited to two tentative estimates in a decade (Sverdrup-Jensen 2002, Hortle 2009), no transparent price per tonne of fish has ever been produced (Baran 2010), and the sector remains dramatically undervalued (e.g. in Cambodia: USD 200-250 million for 300-400,000 tonnes; RGC 2010).

More generally, information about the fishery sector suffers from a lack of clarity about high economic value vs. accessibility to poor households, high productivity vs. low economic performance, strong livelihood value vs. high poverty rates in the sector, and about the distribution of value to different socio-economic groups.

This lack of information results in a poor inclusion of capture fisheries in national policies (Ahmed and Hirsch 1999, Baran et al. 2007), in fisheries being accorded only a minor role in regional development plans (Bush and Hirsch in 2005), and in trade-off analyses biased towards hydropower development (Friend et al. 2009). The current situation results in a significant risk to food security and poverty alleviation in the region, and calls for a better identification of the values of Mekong fish resources.

Need to improve recognition of the role of fisheries in rural livelihood strategies

In Cambodia, strengthening food security is a priority in the *Agriculture Sector Strategy 2006-2010*, the *Strategic Framework for Food Security and Nutrition*, and the *National Agriculture and Water Strategy*. However, the role of fisheries and aquaculture is not prominent in these documents. The country's *National Strategic Development Plan* and the IFM's *Cambodia Poverty Reduction Strategy* both recognize "*the crucial role of fish in the lives of millions of Cambodians in terms of food, nutrition, income and livelihoods*", but the more specific *Strategic Planning Framework for Fisheries* acknowledges that "*the current status of poverty in the fisheries sector is poorly understood.* […] *This results in an under-performing sector with limited capacity for change and a weak knowledge base in government for effective planning within the sector. As a consequence the importance of fisheries to the economy of the country is poorly represented in the policy framework and poorly resourced*" (RGC 2010).

ACIAR's *Fisheries Program Strategy* recognizes the importance of aquatic resources for food security and livelihoods in the Mekong, and the looming threats to these resources. It identifies a need for targeted interventions aimed at improving the value of fish products. Such interventions would require a proper research-based assessment of the multiple values of fisheries. These values need to be assessed and integrated into broader agriculture and rural development strategies and programs, in order to maximize the contribution fish can make to food security, poverty alleviation and the strengthened adaptive capacity of resource-dependent communities.

Several projects funded by DFID and DANIDA in the Mekong region have previously tried to value fisheries resources, but they are either outdated (Ahmed *et al.* 1998), have not been well disseminated nor converted into policy changes (Dixon *et al*. 2003, MRC 2005a), or could not be completed (MRC 2008). There was no field-based assessment of the value of the fishery sector, despite repeated calls for more valuation studies (e.g.

LARS 2003, MRC 2005b). The situation is summarised in the Mekong River Commission's *Strategic Environmental Assessment of Hydropower on the Mekong Mainstream* (ICEM 2010): "*The estimation of the value of capture fisheries remains a neglected issue. The large variation in the value of fisheries is a measure of how little is known about the actual contribution of this sector to the socio-economic system of the LMB. In some respects addressing the valuation in aggregate terms misses the other roles played by fisheries as a source of nutrition and livelihoods for some of the poorest sections of the population.*"

Research activities that address constraints in value chains were one of the priorities of ACIAR, with Cambodia being one of the ACIAR's focus countries in the Mekong. It is a particularly relevant case study for a valuation project because the fisheries contribute most to GDP and livelihoods. As stated by ACIAR, "*it will be important to anticipate research needs associated with value chains that might come under the Program at a later date and to initiate these activities as early as possible".* A better assessment of fish values will feed development projects and contribute to focussing investment where it is most needed.

Research questions

- What is the economic value of capture fisheries in Cambodia, taking a full value chain approach?
- What is the relative contribution of fisheries to welfare in diversified farming systems?
- How does fish support the welfare of poor and vulnerable social groups?
- How can the welfare and livelihood value of fish be increased?

4 Objectives

The overall aim of the project was to quantify the multiple values of fish resources, interpret findings, analyse implications, and convey high level results and implications to national decision-makers, development agencies and local actors, for sustainable and improved rural livelihoods. The objectives of the project were:

Objective 1: Assess the economic value of capture fisheries in Cambodia.

1.1 Fill literature gaps by conducting fish productivity assessments in three habitats, and update market values for the main fish groups in three representative agroecological zones.

1.2 Estimate the economic value of key fisheries and aquaculture products along the full value chain in representative agroecological zones.

1.3 Identify the main changes and trends in the production of different species and the creation of fish products in the different agroecological zones.

Objective 2: Assess the welfare value of fish for rural populations in Cambodia

2.1 Review existing information in Cambodia about the values of fish in rural livelihoods in relation to other natural and agricultural resources, test and refine the welfare value assessment methodology and assess the intra-Tonle Sap variability.

2.2 Conduct a field-based fish-focussed dynamic welfare analysis over two annual cycles in representative agroecological zones and draw conclusions about the values of fish in rural livelihoods for different social groups in Cambodia.

2.3 Identify the main changes and trends in the contribution of fish to the welfare of rural households.

Objective 3: Establish a Mekong regional network for monitoring fish resources in partnership with national universities

3.1 Develop a sustainable and low-cost network for the monitoring of fish resources, through coordinated annual BSc and MSc training programs focussed on fisheries in 4 universities in the region.

Objective 4: Communicate the findings and implications for welfare improvement and management of fishery resources

4.1 Develop summary analyses every year of the assessments related to the economic and welfare values of fish, to trends, and to options for maximizing welfare values.

4.2 Identify, based on experience from recent projects and programmes, policy processes and institutional pathways in order to make an impact on decision-making.

4.3 Develop a communications strategy, produce communication materials and disseminate project methods and findings to project partners, line agencies, decision makers, and the public.

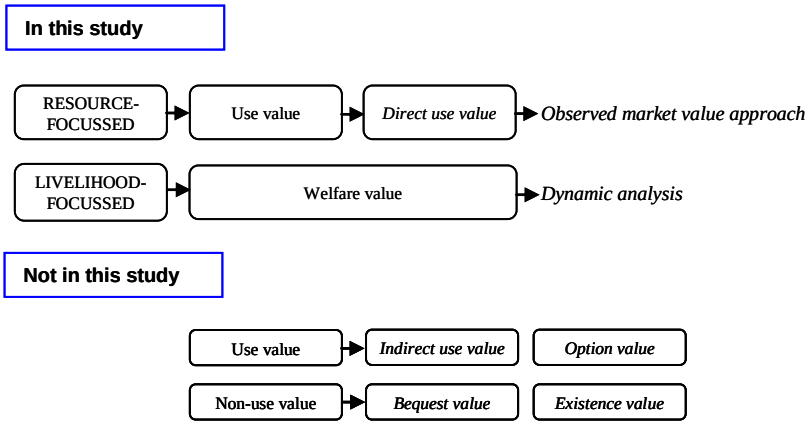
5 Methodology

The present methodology section closely reflects the methodology section of the project proposal; differences are highlighted in footnotes.

The project sought to answer the following research questions:

- What is the economic value of capture fisheries in Cambodia and its value added along the trade chain?[1]
- What is the relative contribution of fisheries to welfare in diversified farming systems?
- How does fish support the welfare of poor and vulnerable social groups?
- How can the welfare and livelihood value of fish be increased?

The research focussed on direct use values of fish resources, but also assessed the welfare values of the resource, i.e. non-monetary (but quantitative and comparative) contribution to livelihoods, at the household level.



The welfare value analysis approach concentrates on the five main components of welfare: activities performed by a household for income generation and asset accumulation (**wealth**), but also ***nutrition, labor, health*** and ***resilience.***

The analysis includes an assessment of variability between agroecozones, wealth groups and gender groups.

Objective 1: Assess the current market value of fish in Cambodia, based on field data.

The review of economic information systems integrates assessments by Coates (2002), FAO (2003), Baran *et al.* (2007) and FAO and WorldFish Center (2008). Since [Total market value = Price per kg x Production], this component required two sub-components: i) assessment of fish market prices (by dominant species and kg), and ii) assessment of Production per habitat[2]. The comprehensiveness of this approach implies that the different modules are successively implemented during years 1, 2, 3 of the project, and brought together during year 4.

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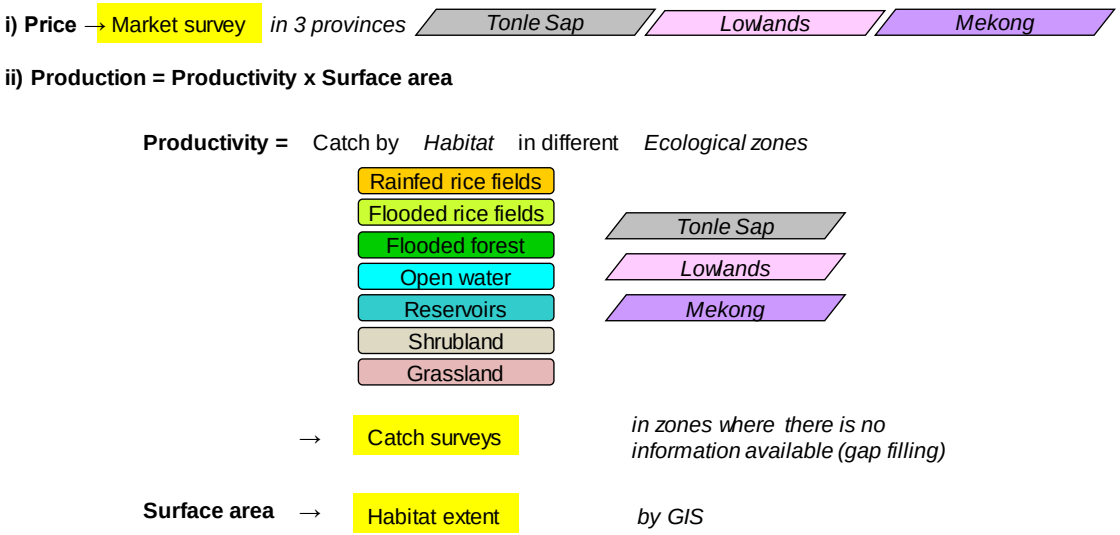
[1] Modified from the original question, which was "What is the economic value of capture fisheries in Cambodia, taking a full value chain approach?"

[2] Five habitats were initially proposed, and seven were actually reviewed and/or surveyed

VALUE = PRICE x PRODUCTION



Market study: This survey built on the work of Yim Chea and McKenney (2003 a,b) Rab et al. (2005, 2006) and on the recent projects "*Trans-boundary fish trade in the Lower Mekong Basin: impacts on fisheries and rural employment in Cambodia, Lao PDR and Thailand*" and "*Value chain analysis of snakehead fish in the Lower Mekong Basin*" involving IFReDI. The market surveys were done in 3 agroecozones (Tonle Sap, Lowlands, Mekong mainstream)[3]. In each place, fish prices at the level of 100 fishermen (first sale), 30 traders and 6 exporters were surveyed every four months over one year, while distinguishing capture fish from aquaculture fish traded.

The field survey was implemented by the Socioeconomic department of IFReDI, and the data was re-analysed by a consultant who also did the reporting.

Productivity study: since the budget did not allow an extensive assessment of the productivity of all habitats, this study combined existing information and gap filling based on field studies. Catch surveys were done in different habitats using:

- trammel nets (most efficient and least selective of all light fishing gears, with a wealth of data already available in the Tonle Sap),

- exhaustion methods:
  - conversion from catch/m^2 of net to catch/ha of habitat (encircling open water areas fished by trammel nets with fine mesh nets, then exhaustive fishing to assess the ratio between trammel catch and standing stock)
  - encircling areas of shrub land with fine mesh nets, then exhaustive electrofishing to assess the standing stock)

Surface area of each habitat was assessed by using the 2003 land-use map produced by the Ministry of Public Works and Transportation under the JICA project '*Cambodia reconnaissance survey digital data*'.

Field survey, data analysis and reporting were done by the Biology department of IFReDI.

[3] Initially, three provinces were proposed for the survey (Pursat, Takeo and Stung Treng); they actually correspond to the above ecozones. In total, six provinces plus Phnom Penh were surveyed and the number of interviewees was upgraded from 204 to 408 (in 3 rounds, i.e. 1 516 questionnaires in total: 1 225 fishers, 241 traders and 50 exporters)

Aquaculture study: In addition to capture fish assessments, fish production in 6 aquaculture production systems identified in Joffre *et al.* 2010 and the ACIAR-funded *Aquaculture Futures* project were updated[4] and improved by close coordination with the Fisheries Administration.

That study was done by a consultant and experts from IFReDI and the MRC.

Objective 2: Assess the welfare value of fish for rural populations in the Mekong Basin

Since low priced fish is the most valuable fish for the poor in the Mekong, the valuation approach intended to go beyond dollar values, building on methodologies developed by WorldFish (Béné *et al.* 2010, Chiwaula *et al.* 2010). This approach examines the welfare value of fish with a specific focus on food security and adaptation to change, in particular among poor households. The survey included an analysis of decisions to allocate land, labour, capital and knowledge to different activities or processes.

Information about the welfare values of fish in rural livelihoods from 4 large projects conducted between 2003 and 2009 was synthesized.

The welfare analysis was used to assess three distinct pathways of poverty vulnerability: i) purchasing power through fish sales, ii) nutritional contribution from fish consumption, and iii) women in the fishery sector[5]. A "dynamic" approach was used to allow identifying critical seasonal features[6]. When identifying changes and trends among fish-dependent households, the project paid particular attention to the role of fish as i) a financial trigger, ii) a bridge of financial and nutritional gaps, especially in the dry season, and iii) an absorber of rural surplus labor. Insights into these roles helped identify targeted activities that development actors can undertake in order to make a positive impact at the community level.

The study was designed and tested by WorldFish in collaboration with CARDI and two statisticians. All field surveys and data entry were done by CARDI. Data were coded, organized and analysed by two data analysts/statisticians and WorldFish scientists. Reporting was a collective effort. Cross-checking of data entry, database content, statistical procedures and results was systematically implemented throughout the study (in particular data of years 1 and 2 were analysed by one analyst, before data of years 1, 2 and 3 were re-analysed by a different analyst).

The study zones selected were consistent with the target hubs of the *CGIAR Research Programme 1.3*: Tonle Sap area, lowland floodplains (Takeo) and Mekong mainstream (Stung Treng)[7]. The first six months of the project were focussed on the testing phase, whose importance is underlined.

The protocol that resulted from the definition of a statistically robust framework, field testing, and identification of technical, financial or logistical constraints differs from what was suggested in the project proposal. The actual protocol and framework are detailed below.

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[4] In the project proposal, 7 systems were mentioned but shrimp farming, the only non-fish system, was not kept for the present review.

[5] In terms of quantitative assessments, the proposal mentioned three categories of indicators (Household income, Consumption and Assets); the surveys done also included Labor, Health and Adaptation (the latter assessment being complemented with more detailed qualitative analyses based on Focus Group Discussions

[6] The proposal mentioned an analysis of factors related to the shift from transient poverty to chronic poverty; this was actually not done in the analysis

[7] The project proposal mentioned that households surveys would be conducted in each province, every second month, during 6 days by 3 surveyors. The actual sampling framework and protocol, resulting from the testing phase, was different.

Sampling effort and representativeness - Each household was subject to a detailed questionnaire implemented by trained surveyors of B. Sc. or M. Sc. level. In total, 747 households in 37 villages located near water bodies countrywide were repeatedly surveyed 3 times over 3 years. The findings are therefore representative of the situation of about 3.7 million of the country's inhabitants.

Agro-ecosystems — The survey concentrated on three agro-ecological zones, namely the Tonle Sap, the Lowlands (between Phnom Penh and Vietnam) and the Mekong (i.e. along the mainstream, upstream of Kratie). These were defined as strata for the survey design.

Fish dependency groups — A fish-dependency indicator was created from a combination of three distinct national datasets, by integrating the following information: (i) total number of persons whose primary occupation is fishing; (ii) total number of persons whose secondary occupation is fishing; (iii) number of families with row boats used for fishing; and (iv) number of families with motor boats used for fishing. In turn, the fish-dependency indicator was used to segment the population into five strata labelled as "very high", "high", "medium", "low" and "no dependency" on fishing activities. With the "no dependency" stratum suffering from under-sampling, further data analysis concentrated on a subsample of 655 households in areas with very high, high, medium and low dependency on fishing.

Gender prevalence groups — The survey sample was segmented into three gender-prevalence groups defined as follows:

- Male-prevalent households — where 60% or more household members are male;
- Female-prevalent households — where 60% or more household members are female; and
- Gender-balanced households otherwise.

Those three groups were further combined with household head gender, labelled as male-headed or female-headed households.

Wealth quadrants — During data analysis, households were also segmented into four quadrants reflecting household net income and household net assets:

	Net income per capita per day equals or exceeds KHR 3 871 (USD 0.93):	**Net income per capita per day is less than KHR 3 871 (USD 0.93):**
Net asset value equals or exceeds KHR 20 000 000 (USD 5045):	Financially sound	Income-insufficient
Net asset value is less than KHR 20 000 000 (USD 5045):	Asset-insufficient	Financially vulnerable

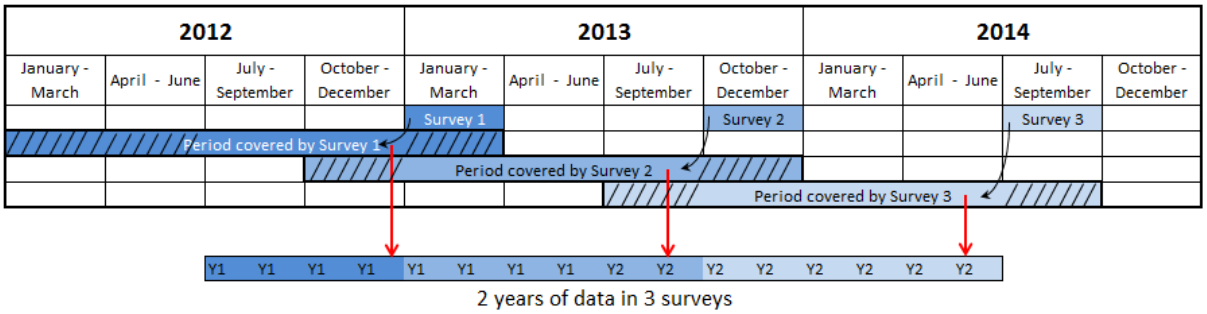
New recording methodology— In order to avoid errors associated with transcribing the data from 52 pages in each of the 747 paper questionnaire into digital files (at a cost initially not budgeted), we developed a methodology using digital tablets for data input and export in the field.

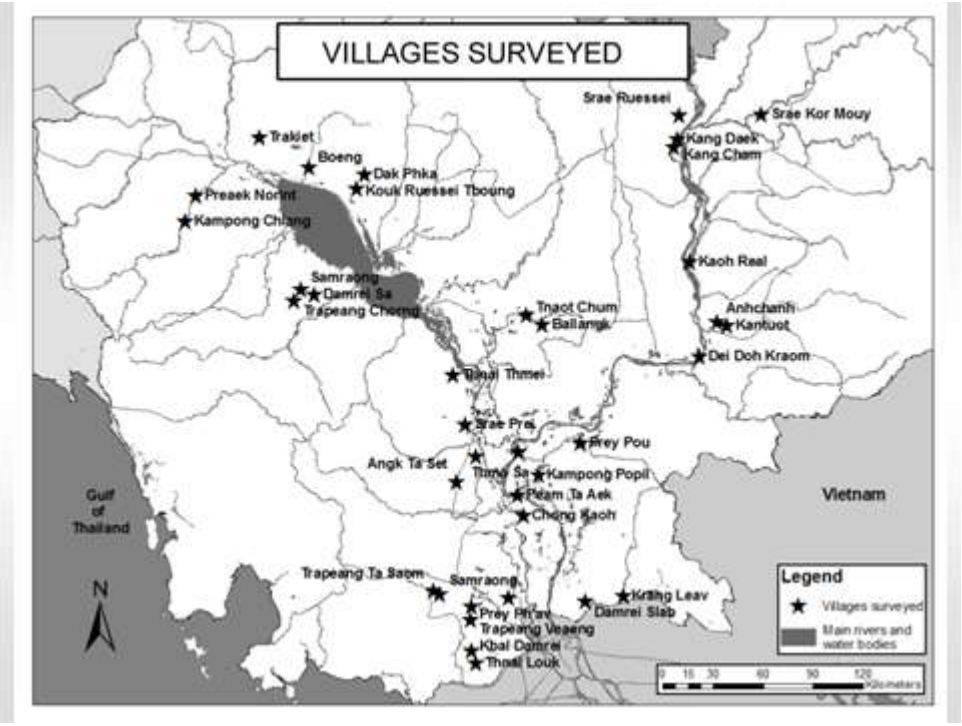
Survey period — While the initial plan was to have a first baseline survey covering 12 months, with 3 follow-up surveys covering 3 months each, we found that it would be as efficient and 25% cheaper to have 3 surveys covering 12 months each. The money saved by not running the last survey was used to pay for the new recording methodology and the training of the often changing surveyors (not initially budgeted).

Survey 1: January to March 2013, covering 2012. To improve quality of data based on recollection by interviewees, only answers about recent months (i.e. July to September 2012) were kept for analysis;

Survey 2: October to December 2013, covering 2013 (only January to September 2013 data were kept for analysis);
Survey 3: July to September 2014 (only October 2013 to June 2014 data kept for analysis).

In total, 2 241 questionnaires were generated. The timing of surveys and location of villages sampled are detailed below.





Objective 3: Initiate a network for monitoring of fish values through partnerships with national universities

A series of BSc and MSc "research" topics commonly agreed and focussed on the long-term gathering of fisheries data was put in place at Can Tho University, the Royal University of Phnom Penh, and Ubon Ratchathani University[8]. The first year of the project was used to define common topics and approaches, the objective being to produce a robust monitoring protocol for the years to come.

One opportunity unforeseen in the project proposal was the similar development of a protocol for standardized fish sampling in Mekong countries by the Scientific Capacity Development Initiative (Sci-Cap) based in Cambodia at IFReDI. Instead of developing duplicate protocols, the University component of the Valuation project teamed up with Sci-Cap and both developed and tested a common protocol.

Objective 4: Communicate the findings and implications for welfare improvement and management of fishery resources

A communication strategy was developed during year 1. The information resulting from activities in Objectives 1 and 2 were processed in order to disseminate findings. Each year, the project team produced reports and briefs to summarize findings. The project team identified institutional pathways to help convert scientific findings into policies and action. These efforts built on previous experiences and lessons (e.g. Israel *et al.* 2005)[9]. Options and opportunities were conveyed to local actors (i.e. fishers, fisher or farmer associations and the public at large) through the substantial use of media (multiple interviews and production of a TV documentary).

[8] As opposed to initial plans, it was not possible to involve Lao universities in the project. The National University of Laos never signed the contract it was proposed; Savannakhet University was visited and proposed to replace NUL, but also stopped responding after a while. It is assumed that the focus on fisheries in the present project was not incompatible with the strong political agenda of dam development in Laos

[9] The collaboration with the CAVAC programme suggested in the project proposal did not take place.

6 Achievements against activities and outputs/milestones

Objective 1: Assess the economic value of capture fisheries in Cambodia

Activities	Status	Expected outputs/milestones	Due date	Actual outputs
1.1 Fill literature gaps by conducting fish productivity assessments in three habitats, and update market values for the main fish groups in three representative agroecological zones	Fully done 2 publications Additional output: 1 book chapter to be published	Review report about fish productivity by habitat and total fish production in Cambodia Review report about market prices of the different fish groups in 5 provinces and added value along the food chain	Semesters 4 and 7 Semesters 2 and 4	**Two project reports** *- Trammel net testing in open waters and preliminary results.* *- Fish productivity of flooded shrublands*. **One publication** *Chheng P., Un S., Tress J. Simpson V., Sieu C. 2016. Fish productivity by aquatic habitat and estimated fish production in Cambodia. Inland Fisheries Research and Development Institute (Fisheries Administration) and WorldFish. Phnom Penh, Cambodia. 23 pp.* **One publication** *Mille G., Hap N., Loeng N. 2016 Economic value of fish in Cambodia and value added along the trade chain. Inland Fisheries Research and Development Institute (Fisheries Administration) and WorldFish. Phnom Penh, Cambodia. 62 pp.* **Project report → one book chapter to be published (see # 4.1)** *Fish market prices and value - survey methodology.* Final review report ready to be published as a chapter of the manual (see section 4.1).
1.2 Estimate the economic value of key fisheries and aquaculture products along the full value chain in representative ecological zones	Fully done 1 publication	Annual project reports about the economic value of fisheries and aquaculture production in the selected zones, and in the whole country (yearly variability integrated to Year 2 and 3 reports)	Semester 8	**One project report** *Aquaculture production in Cambodia -2012 update.* **One publication** *Joffre, O, So N., Chheng P. 2016. Aquaculture production in Cambodia: trends and patterns in recent years. Inland Fisheries Research and Development Institute (Fisheries Administration) and WorldFish. 14 pp.*
1.3 Identify main changes and trends in production of different species and product types in the different ecological zones	Partly done	Reports about main changes and trends in fish production patterns	Semesters 2 and 4	Findings from Aquaculture, Fish market prices and Adaptation components integrated to the final project synthesis

Objective 2: Assess the welfare value of fish for rural populations in Cambodia

Activities	Status	Expected outputs/milestones	Due date	Actual outputs
2.1 Review existing information in Cambodia about the values of fish in rural livelihoods in relation to other natural and agricultural resources, test and refine the welfare value assessment methodology and assess the intra-Tonle Sap variability	Fully done 1 publication	Review report about the quantitative values of fish in relation to other natural and agricultural resources	Semester 2	**Report** *Quantitative values of fish in relation to other natural and agricultural resources - literature review.* **One publication** *Hap N., Un S., Nasielski J. 2016. A review of socioeconomic studies in the fisheries sector in Cambodia. Inland Fisheries Research and Development Institute (Fisheries Administration) and WorldFish, Phnom Penh, Cambodia. 14 pp.*
2.2 Conduct over two annual cycles a field-based fish-focussed dynamic welfare analysis in 3 representative agroecological zones and draw conclusions about the values of fish in rural livelihoods for different social groups in Cambodia	Fully done 1 publication Additional outputs: • 5 book chapters to be published •1 database of 3 years of surveys	Annual project reports about the role and value of fish in the welfare of rural communities studied and in the whole country	Semesters 2, 4, 6, 7	**Four project reports (semester 2)** *(*):* Available online *- Questionnaire development.* *- Development of the survey methodology and protocol description.* *- Fishing dependency in Cambodia - mapping and methodology report.* *- Villages of the welfare monitoring: itineraries & households surveyed. (*)* **Six project reports (semester 4)** *- User manual for tablet-based welfare questionnaires. (*)* *- User manual for the Back Office of the tablet-based questionnaires.* *- Welfare database – I. Questionnaire and database variables. (*)* *- Welfare database –II: Data preparation for analysis.* *- Welfare data analysis – I- Data analysis framework.* *- Welfare data analysis– II. Research questions.* **Four project reports (semester 6)** *- Descriptive statistics for two surveys among fishing dependent villages.* *- Representativeness, statistical weighting and confidence intervals.* *- Welfare data analysis– III. Results from surveys 1 and 2.* *- Welfare data analysis– IV. Role and value of fish in the welfare of rural communities in Cambodia (preliminary results; initial and revised reports)* **Project reports -> five book chapters to be published (see # 4.1)** *-Welfare surveys: concepts and approach.* *- Welfare survey methodology and protocol description.* *- Welfare survey questionnaire development.* *- Welfare survey research questions.* *- Welfare survey questionnaire and database variables.* **Database created (at the household level, Excel and Access formats)** **One publication** *Mousset E., Rogers V., Saray S., Ouch K., Srey S., Mith S, Baran E. 2016. Role and value of fish in the welfare of rural communities in Cambodia (welfare data analysis). Inland Fisheries Research and Development Institute (Fisheries Administration) and WorldFish. Phnom Penh, Cambodia. 103 pages.*

Activities	Status	Expected outputs/milestones	Due date	Actual outputs
2.3 Identify main changes and trends in the contribution of fish to welfare of rural households	Fully done Additional outputs: 3 publications	Annual project reports about main changes and trends in the contribution of fish to welfare of rural households (yearly variability integrated to Year 2 and 3 reports)	Semesters 2, 4, 6, 7	**Project report (semester 2)** *Issues, changes and trends in welfare - methodology report.* **Project report (semester 4)** *Adaptation to environmental change among fishing-dependent households in Cambodia - a qualitative assessment of trends and adaptation processes.* **Project report (semester 6)** *Changes, trends, opportunities and constraints in the contribution of fish to the welfare of rural communities in Cambodia (preliminary results).* **Three publications** • *Schwartz N., Gätke P., Baran E. 2016. Adaptation to environmental change among fishing-dependent households in Cambodia. Inland Fisheries Research and Development Institute (Fisheries Administration) and WorldFish. Phnom Penh, Cambodia. 53 pp.* • *Estepa N., Srey S., Lay R., Theang V., Kuch P., Khun S., Johnstone G., Poulin P., Ouch K., Starr P., Baran E. 2016. Trends, opportunities and constraints in the contribution of fish to the welfare of rural communities in Cambodia. Inland Fisheries Research and Development Institute (Fisheries Administration) and WorldFish. Phnom Penh, Cambodia. 34 pp.* • *Vilain C., Baran E. 2016. Nutritional and health value of fish: the case of Cambodia. Inland Fisheries Research and Development Institute (Fisheries Administration) and WorldFish. Phnom Penh, Cambodia. 45 pp.*

Objective 3: Establish a Mekong regional network for monitoring fish resources in partnership with national universities

Activities	Status	Expected outputs/milestones	Due date	Actual outputs
3.1 Develop a sustainable and low-cost network for the monitoring of fish resources, through coordinated annual BSc and MSc training programs focussed on fisheries in 4 universities of the region	Fully done National University of Laos dropped Additional outputs: •1 PhD •8 M. Sc. theses •1 publication	Report about agreed topics and standardized methods	Semesters 2, 4, 6	**Three project reports** *Establishing a regional network of universities for monitoring of Mekong fish resources - year 1, 2, 3 reports.*
		Reports about implementation, adjustments and results obtained	Semesters 2, 4, 6, 8	**Three project reports** *Same reports as above.* **1 Ph.D. thesis and 8 M.Sc. theses** • Three M.Sc. theses from RUPP University. • One Ph. D. thesis and five M. Sc. theses from Can Tho University, plus involvement of 10 B. Sc. students. • Involvement of 1 PhD, three M.Sc. and 41 B.Sc. students from UBU. **One publication** *Boon L., Elliott V., Phauk S., Pheng S., Souter N., Payooha K., Jutagate T. Duong V. N. 2016. Developing a methodology for standardized fish monitoring in the Mekong Basin. Inland Fisheries Research and Development Institute (Fisheries Administration) and WorldFish. Phnom Penh, Cambodia. 27 pp.*

Objective 4: Communicate the findings and implications for welfare improvement and management of fishery resources

Activities	Status	Expected outputs/milestones	Due date	Actual outputs
4.1 Develop summary analyses every year of the assessments on economic and welfare values of fish, trends, and options maximizing the welfare values	Fully done	Annual briefs summarising the findings of Objectives 1 and 2	Semesters 4, 6, 8	**Semesters 4, 6, 8** Findings presented each year in the form of posters a set of visuals (folder of infographics).
	Fully done	Scientific articles summarizing the results of valuation	Semesters 6 and 8	**Four peer-reviewed publications** • *2014 A digital approach to surveys in developing countries. Pp. 885-892 in WIT transactions on engineering sciences vol. 93. WIT Press, Southampton, UK. 1013 pp.* • *2014 Fish resources in Cambodia (2001-2011). Chapter 4 (p. 37-48) in: Atlas of Cambodia. Save Cambodia's Wildlife, Phnom Penh, Cambodia. 178 pp.* • *2016. Fish and the nutrition of rural Cambodians. Asian Journal of Agriculture and Food Science, 4; 1; 26-34.* • *2016 When is a fisher (not) a fisher in Cambodia? Representations of rural livelihoods in occupational questionnaires Fisheries management and ecology. Accepted, in press.* **Four non-peer-reviewed publications** in addition to those mentioned above (i.e. 14 in total) • *2012 Pathways for fisheries-related information in Cambodia. Catch and Culture 18 (2) 16-19.* • *2013 Updated information on fish and fisheries in the Mekong Basin. Catch and Culture; 19; 3;24-25.* • *2015 Cambodia's fisheries: a decade of changes and evolution. Catch and Culture, 21; 3; 28-31.* • *2015 Evaluation of impacts and solutions to deal with the climate change in the rice - shrimp system in the Mekong Delta. Tạp chí Khoa học Trường Đại học Cần Thơ Phần B: 41: 121-133 (in Vietnamese.)*
	Not done	A manual on the valuation methodology	Semester 8	Manual written but not published, due to funding constraints. Manual consisting of 5 chapters and 2 annexes originating from the above project reports. *-M01 Welfare surveys: concepts and approach* *- M02 Welfare survey methodology and protocol description* *- M03 Welfare survey questionnaire development* *- M04 Issues, changes and trends in welfare – methodological approach* *- M05 Fish market prices - survey methodology* *- M06 Welfare survey research questions (Annex)* *- M07 Welfare survey questionnaire and database variables (Annex)*

Activities	Status	Expected outputs/milestones	Due date	Actual outputs
4.2 Identify policy processes and institutional pathways for impact based on experience from recent projects and programmes, and formulate a communication strategy	Partly done	Report on policy processes and institutional pathways allowing efficient conversion of project findings into policy changes	Semester 2	Connections to policy instruments integrated to the final synthesis of the project.
4.3 Develop communication materials and disseminate project methods and findings to project partners, line agencies, decision makers and the public	Fully done	Communication strategy	Semester 2	**Two project reports** • *Communication strategy.* • *Stakeholders, information flows and impact pathways for fisheries-related information in Cambodia - channels allowing efficient conversion of fishery-related project findings into policy changes.*
	Fully done	Radio interviews, newspaper articles, video interviews on project updates	Semesters 4 and 6	**Three TV news programs in Khmer** On CTN TV (22 July 2014), TV5 (23 July 2014), Hang Meas TV (23 July 2014), Apsara TV (02-08-2016) **Seven online news reports, in English and Khmer** - Deum Ampil (22-06-2012), The Cambodia Herald (21-06-2012), Agence Kampuchea Press (01-07-2013), CEN (22-07-2014, 2 reports). The Cambodia Herald (27-07- 2014), The Cambodia Herald (01-08-2014) **3 paper media articles** - Raksmey Kampuchea (30-06-2013), Raksmey Kampuchea (23-07-2014), Angkor Thom Magazine (28 July-3 August 2014)
	Fully done	Short movies about project findings, in Khmer and English	Semester 8	**Not short movies but one 52' TV documentary :** *Tonlé Sap, the beating heart of Cambodia***.** by Zed Production, 2015. English, French, German, Khmer versions. Broadcasted on TV over Europe Aug. 2015), in Canada (Oct. 2015), in Cambodia (May 2016) https://vimeo.com/139911743 (Password: LAKE)
	Fully done	Annual meetings involving all project partners, including partner universities	Semesters 2, 4, 6, 8	**Annual project meetings held in 2012, 2013, 2014, 2016** Results presented to the Cambodian Association of Parliamentarians for Population and Development (CAPPD) of the National Assembly. **Presentation of project approach and results in 5 international conferences** - 2012 Mekong fish: values, threats and options. International FishBase Symposium. Stockholm, Sweden. - 2013 Role of fish in rural livelihoods in Cambodia: methodology for a welfare-based assessment. 10th Asian Fisheries Forum, Yeosu, Korea. - 2013 Fisheries valuation in Cambodia: a welfare approach. Mekong Environmental Symposium 2013, Ho Chi Minh City, Vietnam. - 2014 A digital approach to surveys in developing countries. International Conference on Information Technology and Management Science, Hong Kong. - 2015 How much does capture fish contribute to rural livelihoods? A welfare approach in Cambodia. Global Conference on Inland Fisheries, FAO, Rome Plans to present at the November 2016 Mekong Forum in Bangkok.

7 Key results and discussion

In terms of project deliverables and from a quantitative viewpoint:

- out of 10 activities detailed in the project logframe, seven were fully completed (including several with additional outputs) and three were partly done;

- out of 17 outputs expected,

  - one (book on methodology) could not be delivered, but the corresponding seven chapters are ready for editing
  - two were partly done (i- Policy processes and institutional pathways analysis and ii- Main changes and trends in fish production patterns were not subject of a stand-alone report but integrated to the final synthesis of the project)
  - fourteen were delivered

More specifically:

The project has generated a database of 2241 detailed socioeconomic surveys and thus thoroughly documented livelihoods in 747 households among 39 villages throughout Cambodia. That database was re-designed into Access format and made searchable at the individual household level, following the recommendations of the mid-term project review. An online-interactive version of the database was even initiated (examples here and here). A second database on fish prices per species, region and season was also generated (120 species, 3 regions, 4 seasons). These databases constitute the most detailed source of information to date on rural livelihoods and fish value in Cambodia.

The project has also generated, during its implementation period:

- four peer-reviewed publications (on fish and nutrition; fish resources in Cambodia, digital surveys, and on representations of rural livelihoods);

- thirteen published reports and/or articles, on:

- Fish production in Cambodia: by habitat; in aquaculture, during the last decade;
- Fisheries: in the Mekong Basin, and a methodology for monitoring basinwide;
- Nutrition: nutritional and health value of fish;
- Socioeconomics in Cambodia: economic value of fish; role of fish in the welfare of rural communities and pathways for fisheries-related information;
- Livelihoods in Cambodia: adaptation to environmental change; trends, opportunities and constraints; and roles of fish in welfare.

Nine of these publications were published in collaboration with the partner institution for a greater sense of ownership and dissemination in the region. These publications, as well as several additional methodological reports are freely available online on the project Facebook page (www.facebook.com/MekongFishValue). The methodological reports (villages surveyed, use of digital tablets for surveys, survey protocols, database structure, etc.) are aimed at documenting the project's methodology, its sites and its data, so that they provide a baseline and can become references for monitoring in the long term. It is the first time in the Mekong that a fisheries-related project generates transparent and publicly accessible databases and sampling protocols. The welfare database has already been shared, for further analyses and upon their request, with UNDP (June 2016) and Conservation International (July 2016).

- presentations in five international conferences, in particular at the 10th Asian Fisheries and Aquaculture Forum (2013), at the Mekong Environmental Symposium (2013) and at the Global Conference on Inland Fisheries (2015).

Seven book chapters (welfare approach methodology) remain to be published (see details in section 7).

The project has also triggered a new scientific collaboration within the Ministry of Agriculture, Forestry and Fisheries, through joint activities between IFReDI and CARDI. This has, for the first time, exposed CARDI to fisheries (which represent one third of the contribution of the agriculture sector to Cambodia's GDP), and has improved the experience of the Fisheries Administration in comprehensive socioeconomic studies, in particular about adaptation and resilience, a field previously not extensively covered.

In terms of capacity building, the outputs of the project include the completion of one Ph. D. and eight M. Sc. theses (three from Cambodia on testing the standardized fish monitoring methodology and 5 from Vietnam on implementing this methodology for different purposes).

Name	Sex	De-gree	Uni	Topic	Location
Gnim Sodavy	F	MSc	RUPP	Monitoring of fish in 3S River network in Ratanakiri Province of Cambodia	Sesan and Srepok Rivers
Men Sophatry	F	MSc	RUPP	Assessment of standardized gillnet for monitoring fish in the 3S River System	Sesan and Srepok Rivers
Chan Bunyeth	M	MSc	RUPP	Trailing Thai Department of Fisheries Method in the Srepok and the Sesan Rivers in Northeast Cambodia	Sesan and Srepok Rivers
Doan V. Nhanh	M	MSc	CTU	Natural fish survey for Tram Chim National Park	Dong Thap province
Ly Van Loi	M	MSc	CTU	Natural fish survey under different land uses	Can Tho city
Le T. Nhu Y	F	MSc	CTU	Natural fish survey in the canal and river systems	Vinh Long province
Le Truc Lam	F	MSc	CTU	Natural fish survey under different land uses	Vinh Long province
Vo T. N. Diem	F	MSc	CTU	Natural fish and it's socio-economic values	An Giang province
Le T. P. Mai	F	PhD	CTU	Overall natural fish assessment under climate changes impacts	Whole Mekong Delta

In the absence of candidate M. Sc. students in Thailand, no specific thesis was generated, but in total 41 B. Sc., 3 M. Sc. and 1 Ph. D. students were involved in the project and trained in fish sampling using standard fishing gears and welfare-related participatory action research.

Capacity building is also illustrated by the involvement of – and publications by- six interns from Canada, France and the USA, who closely interacted with national scientists during their respective six-month internships.

In terms of findings:

- The average fish production of the various aquatic habitats in Cambodia is estimated at 112 kg/ha/year in rain-fed rice fields, 113 kg/ha/year in flooded rice fields, 121 kg/ha/year in reservoirs, 66 kg/ha/year in the flooded forest, 167 kg/ha/year for shrub land, 94 kg/ha/year in open water and 92 kg/ha/year in flooded grassland and swamps. Given their large surface area (72% of all aquatic habitats), rice fields contribute – or can potentially contribute- more than 60% of the total fish production. The second habitat contributing most to the fish production is flooded shrub lands –mistakenly called "flooded forests" in most studies and documents. The smallest production

originates from reservoirs and real flooded forests (i.e. stands of tall trees), whose surface area is very limited. The sum of these production figures per habitat corresponds to a total fish production of 560,000 tonnes per year.

- In the aquaculture sector, nationwide production (i.e. marine and freshwater) exceeded 112,000 tonnes in 2014. Freshwater cage culture dominates the sector (more than 50% of total production), followed by small and medium-sized enterprises (22%) and smallholder high-input ponds (18%). Siem Reap, Pursat and Phnom Penh are home to 61% of the volume of cage culture nationwide, while the lower floodplains feature 79% of the total pond area (but the overall number of ponds decreased by 9% from 2009 to 2014). Marine low-value fish account for 3% of the total feed of animal origin used in aquaculture, and manufactured pellets for less than 1%. Ninety-four per cent of the fish feed used in aquaculture is still provided by Cambodia's inland capture fisheries. The total value of aquaculture production in 2011 is estimated at $114 million.

- In terms of market value, the average value for a tonne of fish at the fishermen's level (weighted average integrating value and proportion in sales of each species over a year) is USD 1,096 a tonne (variation between $632 and $2,032 depending on the zone). That value increases to USD 1,776 a tonne at the level of traders, and to USD 1,813 at the level of exporters. Fish is much more expensive in the Upper Mekong zone than other zones and cheapest in the Tonle Sap.

- At USD 1,096 a tonne, the economic value of inland capture fish production (560,000 tonnes) can be estimated at USD 614 million a year. This represents five times the volume and value of the aquaculture sector. Based on national statistics amounting inland capture fisheries production to 505,000 tonnes and marine capture fisheries production to 120,000 tonnes in 2014, the total value of capture fisheries, at USD 1,096 a tonne, represents nowadays USD 685,000, i.e. approximately 4.5% of the GDP (15.24 billion in 2013).

- Fish is critically important for nutrition and health in Cambodia. An average person eats fresh fish 5 days/week with a total consumption of fish and fish-related products amounting to 43.1 kg/person/year. Fish is the primary source of animal protein and is consumed more than pork, chicken, and beef altogether. Fish is a primary source of protein and lipids, and is a source of micronutrients and omega-3 fatty acids that are not available elsewhere.

- Fish is also the source of protein that is most accessible to poor and vulnerable households. In particular, when people are faced with food insecurity and economic shocks, i) fish supplements household food consumption, and ii) 10% to 30% of households turn to fishing as a way to generate cash.

- Despite the high consumption of fish, malnutrition is widespread in rural Cambodia. Half of surveyed households report severe diet constraints and a quarter having faced food deprivation. Parents report having children with symptoms of malnutrition-decayed teeth, permanently swollen belly, blond hair- in half of the households surveyed. Symptoms of malnutrition are particularly acute among poor households and those located in the Upper Mekong zone. Malnutrition is caused not only by an incomplete or imbalanced diet, but also by poor environmental and health conditions. For example, eighty-one per cent of households do not have access to safe drinking water year-round. Due to pregnancy, social norms and beliefs, women are more susceptible to malnutrition than men. However, households led by a woman show fewer cases of child malnutrition than households led by a man. In order for the average Cambodian diet to be balanced, greater consumption of fruits and vegetables is required.

- Fishing is an activity first for food production and second for income generation—especially among poor households. The average household generates USD 2 917 in annual net income—of which fishing and fish-related jobs contribute only 6%. In terms

of household assets, fishing equipment is low in value and represents only 7% of farming and livestock assets. Low investment requirements are such that fishing is one of the most accessible primary occupations and food production activities for the poorest households, across all agro-ecological zones. In the Upper Mekong, the poorest of the three areas surveyed, an average household catches more fish and consumes more of their catch than households in other zones.

- Within the fish value chain, income is generated from the sale of fresh fish only. An average household catches 216 kg of fish per year, sells 57% of its catch and keeps 23% for home consumption. An average of USD 155 per household and per year in net income is generated from selling fresh fish. Households process on average 59 kg of fish per year (61% of their own catch fish and 39% of market fish). Fish processing, on average, generates losses rather than gains (USD 9 loss per household and per year) because 76% of processed products are kept for household consumption (processing is for most households a preservation constraint; it is profitable only when done on a larger scale as a business, but is then accessible to more affluent households only).

- There is a clear gender-divide in labour among fishing-related activities. Men are more than four times involved in fishing than women, whereas women dominate fish processing and marketing. Economically, men benefit more from fish than women. Households led by a man make USD 325/year in net income from selling fresh fish, while households led by a woman make USD 90. Yet over half of the women surveyed are involved in processing activities (more than they are in any other natural resource dependent activity). Women do not make money from processing fish, but by preserving fish they play an important role in investing in their family's future food demands.

- If the fishing sector was to be developed, post-harvest activities should be improved in parallel. There is a risk that promoting the processing and trade of fisheries products and therefore increasing their economic value reduces the availability of cheap, fresh fish as a primary food item for the most vulnerable groups, who are the least involved in trade. Thus, priority should be placed on improving the processing sector so that economic gains are made during and after processing (by increasing the fresh-to-preserved conversion rate and the market value of processed fish).

- There is potential for aquaculture to become a more profitable livelihood activity and to reduce dependence on capture fisheries in rural Cambodia. Fish farming activities generate more money for less labour compared to most other natural resource dependent activities. For each person fully involved in natural resource-dependent activities (i.e. paid jobs excepted), fish farming generates the third highest income, after orchard/homestead gardening and rice farming. However, aquaculture, in terms of contribution to food production and employment, plays a minor role compared to capture fisheries. Adult involvement in fishing is about ten times greater than in fish farming (22% vs. 2.4%) and fishing produces twelve times more fish for household consumption than aquaculture (50 kg vs. 4.2 kg). Currently, aquaculture is still a long way from reducing rural households' dependence on wild fish.

- Economic shocks are widely experienced among rural households and, worryingly, the primary coping strategy is to reduce food consumption. At least half of all households experience one shock annually. More households are impacted by economic shocks in the Upper Mekong (78% of households concerned) than any other zone. The average cost of shocks experienced by a household amounts to USD 96, the most common and costly shocks being crop loss, medical emergency and social events. In order to cope, a third of households reduce food quantity, frequency, and diversity. During these times, fish remains accessible and fishing becomes a crucial coping option to households exposed to crop failures.

- Villagers adapt to environmental changes with varied success: by their own standards, 32% of villagers consider that in the past ten years they adapted

successfully, 20% moderately and 44% unsuccessfully. Among households with fishing as a primary occupation only 10% consider they adapted successfully. Declining fish abundance, reported in 82% of households, is the most frequently observed environmental change. Unsuccessful adaptation is correlated to low diversification in occupations, difficulty to access credit and remoteness. Successful adaptation is highly correlated with wealth, land ownership and educational level. The most successful adaptive responses are those least subject to environmental change, e.g. business, dry rice farming or livestock raising. The diverse responses received indicate that diversification is one of the major ways to improve adaptive capacity.

8 Impacts

The intended outcomes and impacts of the project were to: i) increased awareness about the value of fish to national economy and welfare; ii) lessons from the project are used to enhance rural livelihoods; iii) integration of fish value to enhance strategies and welfare.

To achieve these outcomes and impacts, the project developed a progressive approach based on i) a detailed, transparent and replicable methodology (methodological credibility); ii) extensive data gathering during 3 years (to ground credibility of conclusions and relevance of recommendations); iii) release of initial results through the media (communication for visibility and public awareness); and iv) communication of results at the political level, building on public awareness.

8.1 Scientific impacts – now and in 5 years

The project has developed an integrated methodology for rural assessments combining quantitative surveys (socioeconomics, labour, nutrition) and qualitative assessments (adaptation, health). This approach builds on a preliminary experience in Africa (Béné & Neiland 2003a, b; Béné *et al.* 2010*)*; it is more comprehensive than standard socioeconomic rural assessments, and more quantitative than the livelihoods approach. It is directly relevant to all countries where a particular natural resource (such as fish) plays an important and under-recognized socioeconomic role (e.g. Bangladesh, Myanmar, Indonesia, Tanzania, etc.).

The project provided, for the first time ever in Cambodia, a rigorous assessment of the price of one tonne of fish at the landing site (weighted average based on catch composition), then its value added along the trade chain. The project also proposed an updated assessment of the fish production based on the productivity and extent of various aquatic habitats, including vast habitats previously overlooked (e.g. flooded shrub land and rice fields). Combining the value of a tonne of fish and annual fish production allows estimating the actual economic value of fish and true contribution of fish to the country's GDP. This approach paves the way for an updated assessment of fish value in the whole Mekong.

Incidentally, the project also developed and implemented a novel technology using digital tablets for field surveys. This methodology, documented by a publication, was since then used in Myanmar (Tezzo et al. 2014) and will be used in a large USAID funded project. Both the World Bank and UNDP enquired (in December 2015 and May 2016 respectively) in view of using this methodology for their surveys in Cambodia.

The results use a largely quantitative language that can be directly integrated into economic trade-off analyses and institutional planning, and thus fill a gap. In the Mekong, the approach contributed new insights to rural development, with integration of terrestrial and aquatic resources, disaggregation by wealth group, gender and zone, and perspectives in adaptation.

In 5 years from now, papers currently drafted, follow up conferences and publication of the methodological book already written (but still unpublished) will have ensured further dissemination of project results. This comprehensive and documented approach will then provide a framework for better assessment of rural livelihoods in tropical countries, for a better integration of fish and fisheries in development agendas. Findings from the Mekong will themselves have contributed to the ongoing move towards a better inclusion of inland fisheries in the rural development and food security agendas (Cinner & Bodin 2010, Béné et al. 2015, 2016, Thilsted et al. 2016).

8.2 Capacity impacts – now and in 5 years

Capacity building is illustrated at the individual level by the involvement of multiple national scientists, and the publication of various project results by seventeen of them, including nine in peer-reviewed publications. This co-authorship accurately reflects the actual involvement of national partners in the studies published.

More generally, a salient point is the creation of exchange visits between project partner universities, as detailed by partners themselves:

- UBU: *"In 2014, ten third-year students have visited sampling sites in Vietnam and were trained in fisheries and aquaculture at Can Tho University".*
- RUPP: *"In the course of their studies, all fully supported students of cohort 8 visited Ubon Ratchathani University and received training in fish sampling method and fish identification techniques. The head of Academic Development and a research officer visited the two partner universities (UBU and CTU) in order to compare the monitoring methods, and develop a consistent monitoring protocol".*
- CTU: *"Since 2012, the fish survey, fish monitoring and data analysis was used for the international training of the wetland university network (wetlandnetwork.org), where 22 university members of China, Myanmar, Lao PDR, Thailand, Cambodia, Vietnam, Malaysia, Japan, New Zealand, United States of America joined the network. Among those, 102 researchers, lecturers, wetland managers have practiced these methods".*

The latter point illustrates the fact that the fish monitoring protocol, initially developed by Sci Cap, tested by partner universities then routinely implemented by them, is also used by 13 other organizations in the region (see publication "Developing a methodology for standardized fish monitoring in the Mekong Basin").

In 5 years it is already foreseeable that capacity building will have continued beyond the current achievements, as detailed by project partners themselves:

UBU "*integrated the monitoring program as one activity of the obligation subject for the fourth year student*"

CTU: "*The trainers' skills in fish surveys, fish monitoring and data analysis will be applied to do fish research for five years in the project named "Lower Mekong research collaboration initiative*" funded by the USA"

However, at RUPP the limited number of students choosing fish in biodiversity conservation did not allow integrating fish monitoring in the curriculum.

Lastly, the extensive welfare surveys implied training numerous surveyors in interactive questionnaires and the use of digital tablets. In total 35 surveyors were trained; seventeen of these surveyors were staff of CARDI, others were graduated students. Most of these surveyors have since then been engaged in other large scale surveys using digital tools, in particular UNDP and World Bank projects.

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

Since the project was explicitly a research project aimed at generating and communicating information, and was completed two weeks ago, it does not claim economic impacts per se.

In 5 years, the main economic impacts of the project are expected at the household level, through a better contribution of fish to income thanks to improvements – identified and

recommended during the current project – in post-harvest processing and in access to credit. Women in particular are likely to benefit most from the recommended options, since they are central to processing and fish trade. At the national level, the most likely economic impact is to be expected from a stronger focus of the government and aid agencies on the "Upper Mekong" communities (Stung Trend and around), identified in the study as the poorest and most reliant on fish resources. In terms of fisheries management, project results about fish dependency by commune and fish productivity by habitat are considered for further development by IFReDI and the European Commission. They could provide a framework for sampling fish catches in selected monitoring points, and therefore get at minimal cost a scientifically sound and representative assessment of trends in fish catches over years.

8.3.2 Social impacts

For the same reasons, the project does not claim social impacts at this point.

Two weeks after project completion and release of final findings, the policy impact of the project is not yet visible. We propose in Annex 1 a summary table of actual and potential outcomes and impacts from the project.

8.3.3 Environmental impacts

The project is indirectly aimed at triggering a better protection of fish through a more sustainable exploitation of the resource base. As such, it may contribute to reducing environmental impacts, but such impact cannot be claimed at this point, nor in five years from now.

8.4 Communication and dissemination activities

A special attention was paid to stakeholder engagement. This is illustrated by three main points:

- communication of all project results through posters, infographics and fact sheets, as illustrated here. For instance, fact sheets in Khmer were shared with national parliamentarians and received good feedback.

- communication to and information sharing with politicians, in particular to the Cambodian Association of Parliamentarians for Population and Development (CAPPD) of the National Assembly. The deputy chair of this association is also chairman of the Standing Committee on Population and Food Security at the Asian Forum of Parliamentarians on Population and Development (AFPPD) and Chairman of the National Assembly Commission on Legislation and Justice. He proposed that project results are presented to a larger group of Members of Parliament, probably in October 2016.

- Communication through the media, as illustrated by presentation of project results in three TV news programs in Khmer, seven online news reports, in English and Khmer, four paper media articles and through one documentary already broadcasted on at least three TV stations in English, French, German and Khmer (see section 2.4.3).

In the coming months, i.e. after the official project end, dissemination of results will continue through the WorldFish office in Cambodia, with in particular meetings with national parliamentarians, presentations at two Technical working groups (identified as the most effective official channels by our study of communication channels) and presentations to donors (EU and USAID).

9 Conclusions and recommendations

In addition to conclusions derived from the studies (see section 7 – Key results), we review below some salient points and lessons learnt during project implementation

9.1 Some lessons learned during project implementation

- A major issue experienced during project implementation was the declining foreign exchange rate, since early 2013, between the Australian dollar and US dollar (40.5% = USD 103,222 cumulated reduction in purchasing power in 2015). This created substantial constraints in the last year and an 8 month delay. The problem could have been minimized by a design ensuring a more steady production of "final deliverables" in the course of the project. In the present case, it was overcome by i) subsidized additional work time by WorldFish staff and reduction of all expenditures; ii) slight reduction in the number of outputs (methodology manual not published) and iii) budget reduction agreed by IFReDI, CARDI and RUPP.

- No Lao university was willing to stay in or join the project, as a probable consequence of the initial decision to focus studies with students on Mekong mainstream fish monitoring near future dam sites. Other universities experienced difficulties finding enough students to undertake the M. Sc. studies for which fellowships were available – which led UBU to creatively reallocate the funding to training in fish biology of B. Sc. students. CARDI provided competent and motivated surveyors, but could not contribute qualified staff and any scientific inputs beyond field surveys. IFReDI, on the contrary, showed active and effective commitment to the project – at the exception of its socio-economic sub-component, whose contribution was also limited to field surveys. Gaps in data analysis were overcome by the hiring of additional consultants.

- Combining national partners, international consultants and graduate interns from international universities is an effective way to contribute to capacity building through on-the-job training while securing delivery of outputs, science quality and joint publications.

- Interactions with stakeholders and dissemination of results are much more effective when findings are presented in the form of posters using infographics. Furthermore, these posters can easily be transformed -and translated- into fact sheets relevant to communication targeting decision-makers.

- National media can be mobilized at a very limited cost. They welcome and ensure a large dissemination of research results focused on poverty alleviation and environmental protection to the public, which in turn triggers donors' and decision-makers' attention and receptiveness.

9.2 Importance of fisheries in Cambodia

- Fish is consumed more than pork, chicken, and beef altogether, is the source of protein most accessible to poor and vulnerable households, and is therefore essential to nutrition and health. That conclusion, already reached 15 years ago (e.g. by the Mekong River Commission), remains absolutely valid nowadays; changes and progress in urban zones should not mask constancy in the countryside. This calls for a strong emphasis on the fact that capture fish remains critical to food security in rural Cambodia.

- Despite the high consumption of fish, malnutrition remains widespread in rural Cambodia. Malnutrition is caused not only by an incomplete or imbalanced diet, but also

by poor environmental and health conditions. This calls for action towards i) better access to drinking water year round; ii) greater production and consumption of fruits and vegetables, for the average rural diet to be more balanced, and iii) health improvement programs, which will result in reduced malnutrition as a secondary beneficial effect.

- Nowadays, fish contributes about USD 600 million a year to the economy of Cambodia, i.e. 4.5 % of its GDP. It also contributes 6% of income of the households studied, and therefore is not a major contributor to rural income. However, when people are faced with food insecurity and economic shocks, 10 to 30% of households turn to fishing as a way to generate cash. Fish also contributes substantially to occupation (one third of men catch fish, one woman out of two processes fish). This implies that the methodology of the national census, focused on questions about “primary and secondary occupations”, is amended in order to reflect the real contribution of fishing activities to occupations and resilience.

- Low investment requirements are such that fishing is one of the most accessible primary occupations and food production activities for the poorest households. This underlines the need, in national plans, to consider fishing as one of the activities specific to vulnerable groups, and to design development activities accordingly.

- Fishing plays the largest livelihood role in the northern provinces of Cambodia, which is related to a higher poverty, occurrence of shocks, malnutrition and vulnerability in these zones. This calls for specific development interventions aimed at reducing dependency on fish in these zones, in particular in a context of dam development.

- Income is generated from the sale of fresh fish only and men benefit more from fish than women. Fish processing is largely a preservation constraint, and is mainly done by women for households’ own consumption. It is profitable only when done on a larger scale as a business. This requires a careful examination of the likely outcomes of initiatives aimed at developing fish processing, in particular their impact on the poorest households, on women and on rural households’ food security.

- There is a risk that promoting the processing and trade of fisheries products and therefore increasing their economic value reduces the availability of cheap, fresh fish as a primary food item for the most vulnerable groups, who are the least involved in trade. Thus, priority should be placed on improving the processing sector without increasing the demand for the cheapest species the poor already rely on.

- Aquaculture has potential to become a more profitable livelihood activity and to reduce dependence on capture fisheries in rural Cambodia. However, this activity plays a minor role in terms of contribution to food production and employment. Also, protein feed in the aquaculture sector in Cambodia is still made up of 96% capture fish. For these reasons, aquaculture is still a long way from reducing rural households’ dependence on wild fish, which underlines the need to develop a balanced strategy not only focused on aquaculture development, but also on management and protection of the capture fish resource.

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- Un Borin, Baran E. 2012. Stakeholders, information flows and impact pathways for fisheries-related information in Cambodia - channels allowing efficient conversion of fishery-related project findings into policy changes. 46 pp.
- 2016 Valuation project results as infographics

DATABASES

- A database of 2241 detailed socioeconomic surveys in 747 households among 39 villages throughout Cambodia, in both Excel and Access format.
- A database of 2012 fish prices per species, region and season (120 species, 3 regions, 4 seasons), at three trade levels (fishermen, traders and exporters).

11 Appendixes

11.1 Appendix 1:

We present below a summary table of actual and potential outcomes and impacts from the project among its various stakeholders.

Stakeholders		Actual outcomes and impacts	Potential impacts	Limitations, gaps
Decision makers	National Assembly, law makers	Summary information about the contribution of fish to food security and poverty alleviation is available and shared. Echoes in the media. Connection to policy instruments identified.	Amendment of existing policy instruments to improve food security, reduce malnutrition, reduce poverty and promote women.	Translation of briefs in Khmer remains needed. Additional influence (beyond that of project scientists) is required for more change.
	Fisheries Adminis-tration	Detailed information about the contribution of fish to food security and poverty alleviation is now available. Strengths, weaknesses and options for action in the sector are identified. Importance of capture fisheries is highlighted. Thoroughly documented baseline in 39 villages throughout the country. Geographic and gender variability are identified. Connection to existing strategies identified.	Interventions to increase the benefits from fish where possible (e.g. geographically distinct actions) and in target populations (e.g. female headed households). Monitoring of trends over the years in the reference 37 villages nationwide. Update of the Strategic Planning Framework for Fisheries. Defense of annual budget and arguments for fund raising in the sector.	More and more specific interventions remain to be detailed. Analysis of trends and changes since the 1998 socioeconomic assessment of fisheries would be helpful.
	Province authorities	Summary information about the contribution of fish to food security and poverty alleviation is available. Feedback from the media about the importance of fish to rural livelihoods. Options for action are identified. Connection to policy instruments identified.	Geographically specific interventions targeting local fish resources protection, local markets, locally vulnerable groups.	Translation in Khmer of briefs remains needed. Geographically specific recommendations could be issued.

Stakeholders		Actual outcomes and impacts	Potential impacts	Limitations, gaps
Donors		Detailed information about the relative contribution of various rural activities to income is now available. Detailed information (e.g. by zone, by gender) about the contribution of fish to food security and poverty alleviation now exists. Specific information is provided about the poor, female households, and vulnerable groups. Identification of preferred adaptation strategies among households, and of gaps in these adaptation strategies.	Identification of possible interventions in relation to most profitable activities and to improved nutrition. Identification of bottlenecks and possibly counter-productive interventions. Emphasis on the positive role of fish and vegetables in nutrition and malnutrition reduction. Methodology available for use in other countries reliant on inland fisheries (e.g. Laos, Tanzania, Mali).	Dissemination of project results to different donors could be further detailed and tailored.
Private sector	Investors	Identification of trends in the sector, in particular in aquaculture. Identification of best return-to-investment activities in the sector.	Increased or optimized investment in the sector.	Project outputs do not specifically target investors (translation, format, media)
	Fishers	Identification of best fish prices per geographic area and season Identification of most promising geographic zones for fishing	Optimized investment in the sector	Project outputs do not specifically target fishers.
Line agencies		Improved cooperation within MAFF (new collaboration between IFReDI and CARDI) Opening of CARDI to fisheries issues representing 1/3 of the contribution of the agriculture sector to Cambodia's GDP. Experience gained by FiA in comprehensive socioeconomic studies, in particular about adaptation and resilience.	Further collaboration to be promoted, using in particular the channels identified during the project (e.g. Technical Working Groups)	Sustained collaborations require funding and joint fund raising.

Stakeholders		Actual outcomes and impacts	Potential impacts	Limitations, gaps
Research organizations		Uniquely detailed socioeconomic information covering 3 main ecozones in the country. Large database available for more research. New methodology developed for welfare assessments in developing countries. New data gathering tools based on digital tablets developed.	More detailed findings about the role of inland fisheries in rural livelihoods. Active contribution to the development agenda underlining the role of inland fisheries in rural livelihoods.	Full methodology not published yet.
Universities in the region		Collaboration initiated between 3 universities. Experience in exchanging students and/or research topics between universities. Large socioeconomic database available for more research. Opportunities for students to work in the Cambodian villages already surveyed, with a baseline available.	Sustained collaborations between universities. Sustained monitoring of fish in Thailand and Vietnam.	Since environmental conditions differ, it is difficult to implement a common and relevant fish monitoring protocol from Thailand to Vietnam.
The population	Villagers	Identification of most successful adaptation strategies among households, and of gaps in these adaptation strategies.	Better collective adaptation strategies at the village level.	Project outputs do not specifically target villagers
	The public at large	Information about the role of fish in livelihoods received through multiple channels (radio, newspapers, TV news, TV documentary).	The public can influence local authorities and decision makers through feedback during consultations and political meetings.	No pathways for feedback from the public to the project.