

# Designing and Implementing Payments for Environmental Services Schemes: Experience from Lao PDR

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J. Bennett, P. Kyophilavong, G. Scheufele, M. Renton and X. Tsechalicha



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J. Bennett<sup>a</sup>, P. Kyophilavong<sup>b</sup>, G. Scheufele<sup>a</sup>, M. Renton<sup>c</sup> and X. Tsechalicha<sup>a</sup>

<sup>a</sup> Crawford School of Public Policy, Australian National University

<sup>b</sup> Faculty of Economics and Business Management, National university of Laos

<sup>c</sup> School of Plant Biology, University of Western Australia

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Project webpage

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# 1. Introduction

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## 1.1 Context

- The goal is to provide a guide to the design and implementation of a Payment for Environmental Services (PES) scheme.
- The context is environmental protection in developing countries.
- The guidance comes from the experience of the ACIAR project team in designing and implementing two biodiversity focused PES schemes in Lao PDR:
  - Phou Chomvoy Provincial Protected Area (PCV-PPA)
  - Phou Khao Khouay National Protected Area (PKK-NPA)
- The following resources are available at:  
<https://ipesl.crawford.anu.edu.au/>:
  - Research Reports
  - Policy Briefs
  - Survey material
  - Bio-physical model (R code)
  - Training and community consultation packages

## 1.2 Justification for a PES scheme

- Environmental services are often not bought and sold in normal markets.
- They have 'public good' or 'common pool' characteristics.
- Property rights are not well defined or defended because it is too costly to do so.
- These costs are called 'transaction costs', mostly caused by a lack of knowledge/information that in turn causes uncertainty.
- Without secure, certain rights in place, privately motivated exchange is unlikely to occur.
- But the benefits of the environmental services to society can be greater than their costs of supply, including transaction costs.
- Intervention by government can be warranted.
- For example:
  - Direct supply (e.g. government owned and managed national parks)
  - Indirect intervention (e.g. government taxes on actions that harm the environment and subsidies on actions that help the environment).

## 1.3 What is a PES scheme?

- A PES scheme is an alternative to direct supply and indirect intervention.
- Third parties (including government entities, NGOs, Research organisations) can act as ‘agents’ to lower the transaction costs so that exchange between buyers and suppliers of environmental services becomes worthwhile.
- A PES scheme involves an agent (or agents) intervening to lower the transaction costs of buyers and/or suppliers of environmental services so that mutually beneficial trades can occur.
- PES schemes:
  - Create markets where they otherwise don’t exist.
  - Involve people who want an environmental service (buyers).
  - Involve people who can supply the environmental service people want (suppliers).
  - Involve people who can bring buyers and suppliers together by lowering transaction costs (agents).
- A PES scheme should:
  - Ensure that buyers and suppliers are better off.
  - Create a net benefit for society as a whole.
  - Involve voluntary involvement by suppliers.
  - Generate more environmental services than before.
  - Be transparent.
- A PES scheme should follow market principles
  - A price per unit of environmental service output is paid by buyers.
  - A price is paid to suppliers per unit of input made to the process of producing an environmental service.
  - The price is determined in a competitive process.
  - The price is determined by the equating of the willingness of suppliers to supply and the willingness to pay of the buyers.

## 1.4 References and materials

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- ❖ Policy Brief 1 'Concept of PES schemes and project overview' (2013)
- ❖ Policy brief 2: 'How to build a PES scheme' (2014)

## 2. Scope

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### 2.1 Defining a PES scheme's purpose

- What is the goal?
- Identify a problem – define the environmental service
  - Biodiversity?
  - Water quality?
  - Air quality?
- What is the cause of the problem?
  - Policy?
  - Transaction costs?
- Is a PES scheme a possible solution?

#### Our PES schemes

- Biodiversity protection is the environmental service.
- International concern exists over the loss of rare and endangered species due to poaching.
- Laws prohibit poaching (and some hunting) so there are legal property rights established.
- But the rights are poorly enforced in Lao PDR.
- And they are not private rights so there can be no market.

## 2.2 Defining its geographical area

- Define the geographic extent of the problem and its causes:
  - Where are the environmental services wanted?
  - Where does the problem originate?
  - Are the people involved local or distant?
- Can be bio-physically limited:
  - A catchment area
  - An ecological zone
- Can be politically/bureaucratically limited:
  - National/provincial boundaries
  - Land use zone (designated protected area)

### Our PES schemes

- Two 'pilot' case study sites contain the threatened species:
  - PCV–PPA: an array of rare and endangered species
  - PKK–NPA: the Green Peafowl
- Areas are defined by the administrative area of the PCV-PPA and PKK-NPA.
- Suppliers are living next to the areas.
- Buyers may be domestic and international.

## 2.3 Defining its time frame

- Is the problem (and hence the solution) short term or long term?
  - Immediate problem relating to infrastructure development (e.g. water pollution from construction site).
  - Poaching pressure on wildlife populations.
- Are the people affected by the problem one-off or multiple users of the environmental service?
- Are the people who can provide the environmental service long term or short term residents?

### Our PES schemes

- Wildlife poaching is a long term problem that will require sustained actions by suppliers.
- Regular renewal of supply contracts will be required to account for changes in supplier populations and costs.
- Demand may be long term (existence of species will provide long term value) but visitors to Lao PDR may only be in a position to purchase during their short term visit.

## 2.4 Identifying actions that produce environmental services

- What can be done to produce the environmental services?
- Actions or 'inputs' that will produce environmental service 'outputs', e.g.:
  - Planting trees.
  - Restoring habitat.
  - Stream bank stabilisation.
  - Anti-poaching patrols.

### Our PES schemes

- Anti-poaching patrols (performed as teams)
  - Detection and reporting of poacher activities
  - Dismantling of snare lines and collection of snares
  - Dismantling of poacher camps
  - Wildlife monitoring
- Community Conservation Agreements
  - Recognition of the laws associated with hunting wildlife
  - Voluntary agreements on wildlife protection to cover 'legal grey areas'
  - Support for anti-poaching patrols

## 2.5 Identifying potential buyers

- Who are the people who want the environmental services?
  - Who 'complains' about the problem?
  - Who are the direct users of the services?
  - Consider locals as well as visitors and the international community for significant environmental services.
  - Do they have enough wealth to pay?
  - Consider organisations as well as individuals as they can reduce the transaction costs of coordinating individual buyers.

### Our PES schemes

- International tourists visiting Lao PDR
- Lao PDR residents with disposable income

## 2.6 Identifying prospective suppliers

- Who has the skills?
- Who has the time?
  - Locals will have lower travelling costs.
  - What are the 'opportunity costs' of potential suppliers? People with few other opportunities are likely to be more interested.
- Who has an interest?
  - Do the potential suppliers also enjoy benefits from the environmental services produced? People who gain benefits from the work are more likely to be interested.

### Our PES schemes

- Residents of 14 villages surrounding the two case study sites
- Relatively poor rural settlements
- Familiar with the local environment and so have the skills to conduct patrols
- Concerned by the activities of poachers who come from outside the district

## 2.7 Identifying agents

- Anyone seeking to establish a PES scheme, takes on the role of an ‘agent’.
- An agent can:
  - Lower transaction costs by collecting and analysing information.
  - Negotiate agreements between buyers and suppliers.
  - Coordinate and manage the operations of suppliers.
  - Formulate and enforce funding arrangements.
  - Act as a ‘clearing house’ for funds.
  - Mediate disputes between buyers and suppliers.
- Who has the skills?
  - Government agencies
  - Research organisations
  - NGOs

### Our PES schemes

- ACIAR research project collaborators with skills from the National University of Laos, Australian National University, and University of Western Australia (collect and analyse data, conduct negotiations, facilitate payments, etc.)
- Government agencies including the Ministry of Agriculture and forestry and its provincial and district offices, Environmental Protection Fund (clearing house, negotiations, coordination, etc.)
- NGOs and the Wildlife Conservation Association of Lao PDR (collect and analyse data, coordination, etc.)
- The World Bank (seed funding)

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- ❖ Policy brief 2: 'How to build a PES scheme' (2014)

## 3. Demand

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### 3.1 Estimating demand

- To determine the price paid by buyers and paid to suppliers, a demand function needs to be estimated.
- This is a relationship between willingness to pay for environmental services and the quantity of environmental services 'purchased'.
- But environmental services are not bought in markets so markets cannot be used as a source of information.
- Need to use non-market valuation techniques to estimate demand.

## 3.2 Non-market valuation techniques

- Revealed preference techniques include:
  - Travel cost method
  - Hedonic price method
- Revealed preference techniques are suited to 'use' types of environmental services (recreation and amenity values).
- Stated preference techniques include:
  - Contingent valuation method
  - Choice modelling
- Stated preference techniques are suited to 'use' and 'non-use' types of environmental services ('existence' values).

### 3.3 Selecting a non-market valuation technique

- All methods require the collection of primary data.
- Use the technique/s that best handle the type of environmental service being demanded.
- Use the scope definition of PES 'buyer' to target the data collection.
- May require multiple data collection exercises focused on different 'segments' of demand (type of buyer and type of environmental service if there are more than one).

### 3.4 Benefit transfer?

- It may be possible to use 'benefit transfer'.
- Look for other valuation studies that have been done in closely related contexts:
  - Similar environments
  - Similar actions and outcomes
  - Similar people impacted
- Use the demand estimates from the related study in the current context.

### 3.5 Choice Modelling

- The choice modelling technique requires respondents to a questionnaire to make choices between alternative future scenarios of managing natural resources.
- The choices made by respondents shows their willingness to pay for improved environmental services.
- The choices made by respondents involves ‘trade-offs’ between good things (like improved environmental services) and bad things like having to pay money.
- The payment of money is through a realistic and consequential ‘payment vehicle’.
- The payment vehicle helps to identify ways to raise funds for PES.
- Payment is not voluntary given the ‘public good’ or ‘common pool’ nature of the environmental services.

#### Our PES schemes

- Used Choice Modelling (a stated preference technique) to estimate demand
- Focused on non-use values of protecting endangered species in PKK-NPA and PCV-PPA
- Focused on two populations of buyers:
  - International tourists visiting Lao PDR
  - Urban residents of Vientiane City
- Required separate samples and different questionnaires for all variations to estimate different demands
- The choice modelling technique required respondents to a questionnaire to make choices between alternative future scenarios of managing the protected areas.
- Outcomes of the alternatives were described in terms of the following attributes:
  - Species protected
  - Poaching level
  - Households supported by payments
  - Visitation permitted

- Cost to the respondent
- The choices made by respondents shows their willingness to pay for improved environmental and social services.
- Payment vehicles:
  - International tourists visiting Lao PDR: a levy on their entry visa
  - Urban residents of Vientiane City: a surcharge on their electricity bill

### 3.6 Aggregating demand

- Take value estimations from the surveys of individuals (or households) and extrapolate them to the relevant populations.
- Take into account the non-response rate in the survey.
- Take into account the number of units of the environmental service created.
- Extrapolation over time:
  - Demand is likely to occur over time.
  - Consider the time period used in the willingness to pay questions: payment per month, one off payment.
  - For how long were the environmental services being provided?

#### Our PES schemes

- Demand for the environmental service 'biodiversity' was aggregated over:
  - Attributes (species protected and poaching level)
  - Buyer populations (tourists and residents)
  - Contracted supply period (3 years)

### 3.7 References and materials

- ❖ Scheufele, G. and Bennett, J. (2017). Can Payment for Ecosystem Services Schemes Mimic Markets? *Ecosystem Services* 23: 30-37
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- ❖ Policy Brief 3 'Project update' (2016)
- ❖ Choice Modelling survey material

## 4. Supply

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### 4.1 Encouraging supply

- An effective incentive structure faced by prospective suppliers needs to be developed.
- An effective incentive structure incorporates:
  - Returns to prospective suppliers
  - Payment transfer mechanism
  - Mechanisms to monitor supplier performance
  - Penalty system for supplier non-compliance
  - Links between suppliers and the suppliers' broader communities

#### Our PES schemes

- The incentive structure linked prospective patrol teams with the broader community.
- Incentives face by the prospective patrol teams:
  - Payments for patrolling (including bonus payments for specific tasks)
  - Health and accident insurance
  - Equipment
  - Recognition
  - Enforcement of legal restrictions in use of natural resources
  - Penalties for non-compliance
- Payments to patrol teams are delivered in cash by the patrol manager.
- Incentives faced by the broader communities:
  - Payments to village funds (fixed amount and variable amount linked to the teams' patrol efforts)
  - Recognition
  - Enforcement of legal restrictions in use of natural resources
- Penalties for non-compliance
- Payments to village development funds are transferred from the agent to the respective village bank accounts.

## 4.2 Estimating supply

- To determine the price paid by buyers and to suppliers, a supply function needs to be estimated.
- This is a relationship between willingness to accept for 'producing' environmental services and the quantity of environmental services 'produced'.
- But environmental services are not bought in markets so markets cannot be used as a source of information.
- Use conservation auctions to recruit suppliers and estimate supply costs.

### 4.3 What are conservation auctions?

- Prospective suppliers bid to produce environmental services or perform actions that produce environmental services in return for a payment.
- Expected differences in opportunities costs across the year can be accounted for by requesting separate bids for different seasons.
- Marginal costs of supply are determined by each suppliers' opportunity costs (e.g. opportunity cost of time).
- Competition among bidders provides incentive to reveal 'true' marginal opportunity costs of supply net of any personal enjoyment from supplying.
- Auctions generate an individual supply function for each bidder.
- Information on marginal costs allows a distinction between low-cost and high cost suppliers (cost-effective supply).

## 4.4 Designing and implementing conservation auctions

- The environmental service(s) to be supplied or the actions that ‘produce’ the environmental service(s) need to be defined
- Auction rules need to be determined that set out:
  - Bidding format
  - Supplier selection mechanism
  - Price setting mechanism
  - Bidding procedures

### Our PES schemes

- The prospective suppliers perform anti-poaching patrols in the protected areas of the two case study sites.
- Prospective suppliers formed bidding teams.
- Each team chose the number of patrols for a pre-specified range of prices (teams chose only quantities).
- Each team had to submit:
  - One bid for the ‘busy’ season (rice planting and harvesting season)
  - One bid for the ‘quiet’ season (remaining months)
- Pre-specified price range based on the range of opportunity costs in the two case study sites.
- Bidding format:
  - Single round (bidders submit one bid for each season)
  - Sealed bids (bids are confidential)
- Price setting mechanism:
  - A uniform price per patrol was determined through supply and demand.
- Supplier selection mechanism:
  - Everyone who met a set of basic eligibility criteria had the opportunity to participate in the auctions.
  - Teams were selected through a self-selection process (each team stated how many patrols they want to do at the respecified prices).
  - Teams were offered the number of patrols they each bid at the determined price per patrol.

- Bidding procedures:
  - Team members were allowed to bid on behalf of the whole team.
  - Bids only became valid if all team members had signed the bidding forms.
  - Teams were not allowed to communicate with each other.
  - Teams submitted their bids within a sealed envelope.
- The obtained sequences of price–quantity pairs track bidding teams’ individual marginal cost functions.
- Number of patrols offered is a function of price per patrol.
- While the price range is the same for all teams, the offered number of patrols for each price varied across teams given different opportunity costs.

## 4.5 Challenges of conservation auctions

- General challenges that need to be addressed include:
  - Maximising competition among bidders
  - Mitigating the risk of conflicts that may be caused through competition
  - Minimising anchoring effects related to previous payments and payments in other areas
  - Handling potentially low education and experience levels of bidders
  - Minimising transaction costs faced by agents and bidders
  - Ensuring auctions are perceived as ‘fair’
- Degree of competition depends on:
  - Extent of opportunities for collusion
  - Number of bidders
  - Extent to which the bidders’ opportunities costs differ
  - Bidding format

### Our PES schemes

- Collusion was minimised by sequencing the auctions such that communication opportunities were limited.
- Low education and experience levels of bidders were addressed by an intensive information and training process.
- Transaction costs faced by agents and bidders were kept as small as possible by ‘grouping’ training and information sessions.
- Potential concerns about fairness were addressed by self-selection of prospective suppliers and uniform pricing:
  - Participation process is socially inclusive.
  - Suppliers have the opportunity to earn a surplus.
  - Low cost suppliers (suppliers with the least income and employment opportunities) were offered more patrols and earn higher surpluses than high cost suppliers.

## 4.6 Aggregating supply

- Individual supply functions are aggregated to generate a ‘market’ supply function.
- Any costs that are not accounted for in the bids (‘external costs’) need to be added.

### Our PES schemes

- Individual marginal cost functions were summed horizontally to estimate a ‘market’ supply function.
- ‘External costs’ associated with purchasing insurance, purchasing patrol team equipment, bonus payments, employment of a patrol manager, and payments to villages were added.
- Individual supply functions are aggregated to generate a ‘market’ supply function.
- Any costs that are not accounted for in the bids (‘external costs’) need to be added.

## 4.7 Managing community engagement

- Recruitment of prospective suppliers needs to be embedded in a comprehensive community engagement process.
- Community engagement process has to include both suppliers and the suppliers' broader communities.
- The community engagement process should incorporate the following elements:
  - Gathering of information from communities
  - Providing information to communities
  - Consulting communities
  - Negotiating community engagement
  - Training bidders
  - Conducting auctions

### Our PES schemes

- A comprehensive community engagement process was conducted in both case study areas
- The process consisted of the following steps:
  - Village selection
  - Resource overview
  - Community consultations (first round)
  - Community consultations (second round)
  - Conducting conservation auctions

### Village Selection:

- The villages were selected based on the following criteria:
  - Nomination by the GoL
  - Proximity to the PCV-PPA
  - Potential to become guardians of wildlife and forest resource within the PCPPA
  - Some village use of wildlife and forest resources within the PCV-PPA
  - General willingness to participate in the pilot PES scheme (assessed through initial village information and consultation sessions)

- The village selection involved orientation workshops on the PES scheme objectives and implementation process held at the provincial and district levels with GoL officials in attendance.

#### Resource Overview:

- The resource overview was based on the results of a community survey:
  - Interviews with randomly selected households on demographics, social, and economic factors related to economic survival, living standards, and wildlife resources use within the protected areas
  - Survey material: interviewer instructions, a questionnaire, satellite images of the villages and the PCPPA, images of wildlife species, and livelihood activity cards
  - Participation in the survey was voluntary and the names of the respondents were not recorded to ensure anonymity and confidentiality.
  - Data was used to develop village-level community resource profiles

#### Community Consultations (first round):

- The first round of the community consultations perused the following goals:
  - Inform the communities about the concept of the pilot PES scheme and the associated opportunities of participation.
  - Consult with the communities about the elements of the PES scheme design and the proposed process of implementation.
- The first round of consultations was facilitated by selected GoL staff and selected villagers, trained by project staff.
- Comments and suggestions provided during the training were used to revise the PES scheme design and community consultation material.
- The first round of the community consultations was structured along the following topics:
  - PES scheme concept (What are PES schemes and how do they work?)
  - Opportunities of participation (Who can be part of the PES scheme?)
  - Anti-poaching patrol scheme design (What will the patrol scheme look like?)
  - Community benefits (What will your community get?)
  - Conservation auctions (How will the price per patrol be determined?)
  - Payment transfer (How will the money get to your community?)

- Penalty system (What happens if your community does not honour the commitments?)
- Mechanism for grievance, conflict resolution and redress (How can your community file a complaint?)
- Contracting (How will we formulize the commitments?)
- Invitation to register an expression of interest (How can your community register an expression of interest?)
- Process of community engagement (What are the next steps?)

#### Community consultations (second round):

- The second round of the community consultations perused the following goals:
  - Present the community resource profile.
  - Respond to the feedback received during the community consultations and discuss corresponding adjustments made to the PES scheme design and the proposed process of implantation.
  - Engage the communities in the development of a community action plan and community conservation agreement.
- The first round of consultations was facilitated by selected GoL staff and selected villagers, trained by project staff.
- Comments and suggestions provided during the training were used to revise the community consultation material (including the community conservation agreement).
- The second round of the community consultations was structured along the following topics:
  - Recap of suggested PES scheme
  - Response to feedback received during the first round of community consultations
  - Discussion of the community resource profile
  - Legal restrictions on wildlife use
  - Development of a community action plan
  - Development of a community conservation agreement
  - Next steps

#### Conducting conservation Auctions:

- Conducting the conservation auctions perused the following goals:
  - Select prospective suppliers of anti-poaching patrols.

- Estimate the marginal costs of anti-poaching patrolling.
- The auctions were facilitated by selected GoL staff and selected villagers, trained by project staff.
- Comments and suggestions provided during the training were used to revise the conservation auction material (including the patrol contracts).
- The conservation auctions were structured along the following topics:
  - Recap of suggested anti-poaching patrol scheme (including a response to the community feedback)
  - Environmental code of conduct
  - Physical and cultural resources chance-find procedures
  - Patrol contracts
  - Bidding training
  - Bidding for patrol contracts
- Experiences and challenges:
  - Access to remote villages is difficult
  - Low literacy rates
  - Mainly subsistence farmers - limited exposure to markets
- Transaction costs borne by prospective suppliers and agents

## 4.8 References and materials

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Area. Crawford School of Public Policy, Australian National University, Canberra.

- ❖ Scheufele, G. and Bennett, J. (2017). Research Report 16: Costing biodiversity protection: Payments for Environmental Services schemes in Lao PDR. Crawford School of Public Policy, Australian National University, Canberra.
- ❖ Bio-physical models (R code)
- ❖ Expert survey material
- ❖ Household survey material
- ❖ Community training and consultation packages

## 5. Linking demand with supply

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### 5.1 Context

- Link is established by integrating information on demand estimated in 'output space' and supply 'estimated in 'input space'.
- This requires to 'convert' demand estimated in 'output space' into 'input space'.
- This is achieved by estimating production functions.
- The production functions are based on predictions made by means of bio-physical models.

## 5.2 Bio-physical modelling

- What are models?
  - Models are simplified representations of complex natural and socio-economic systems.
  - Models can help to understand complex environmental problems.
- Example model objectives:
  - Help to better understand systems and processes
  - Reconstruct past or predict future behaviour
  - Help to run ‘experiments’ that may not be possible to carry out in reality
  - Find the optimal control management path over time
  - Guide development and assessment of new policy decisions using ‘Decision Support Tools’
- ‘Decision Support Tools’ are computer models that help you make decisions.
- For example: a model to predict the spread and impact of weeds on agricultural yields
- In a PES scheme, we can use models to predict:
  - What type of management actions impact the environment?
  - How much will a management change affect the environment?
  - What is the marginal change in environmental conditions resulting from management actions?
- Good modelling practices are important to keep focused.
- Following a well-defined model development process can prevent many problems at a later stage.
- Possible problems (e.g.):
  - Not answering the questions that are relevant to decision makers.
  - Focussing on building a complex system model, rather than answering the research question.
  - Using the wrong type of model for the question.
- Model development:
  - Define the problem
  - Develop a conceptual model
  - Collect the relevant data

- Estimate/ solve the model
- Validate and apply the model
- Modelling always involves trade-offs between:
  - realism
  - precision
  - generality
- Questions to address:
  - What system will we look at? (a system is a set of interrelated components and the relationships between them)
  - What management actions are feasible?
  - What management actions have a demonstrable impact on the environment?
  - What environmental features are we interested in?
  - Can we measure the changes in environmental features, as effected by management?
- Potential modelling approaches investigated included:
  - Dynamic population modelling
  - Spatial dynamic population modelling
- Stochastic dynamic population models were developed in R for both case study areas.
- Remember that all models are partial. They will never represent the entire system (keep it simple).
- Models are built for a specific purpose. It may not serve other purposes.
- Models are built for a certain scope. They may not have validity outside the time/scale region.
- Always keep your objectives in mind. What is it that you are trying to achieve?

### Our PES schemes

- Most important management problem: poaching is degrading wildlife populations.
- How much does poaching currently impact wildlife populations?
- What can we do to prevent poaching?
- Which wildlife species are of most interest?

- Can we predict the size of the effect if we reduce poaching?
- Steps:
  - Gather general information
  - Understand the problem, the main drivers, the most likely solutions, and the impact of those solutions
  - Target species identification
  - Compile spatial data
  - Construct the model
  - Analyse the model
  - Use the model to generate predictions
- The model for PCV-PPA simulated the following processes on a monthly basis:
  - Wildlife death from illegal snares
  - Wildlife death from illegal direct hunting (shooting, collection, etc.)
  - Wildlife maturation and reproduction
  - Reductions in number of poachers and/or snares as a result of anti-poaching patrols
  - Possible introduction of new poachers and possible movement of poachers and anti-poaching patrols
- The model for PKK-NPA simulated the following processes on a monthly basis:
  - 80km<sup>2</sup> core area was considered to be quite homogeneous (spatial but homogeneous)
  - Age-structured population model
  - Reproduction and aging occurs once per year
  - Poaching and other mortality occurs once per month
  - Cells may be patrolled zero, one or more times per month
  - Each patrol has a chance of discouraging poaching
  - Poachers may return
  - Multiple runs to account for stochasticity

### 5.3 Determining a 'market' price and quantity

- The efficient price and quantity in 'input space' is determined by the equating supply (marginal costs) with demand (marginal benefits).
- The efficient quantity of input represents the sum of the input quantities each prospective supplier bid in the auction.
- Each prospective supplier is offered the number of patrols they each bid at the efficient price (self-selection).

#### Our PES schemes

- The efficient price per patrol and the efficient number of patrols were determined by equating 'market' supply with 'market' demand for patrolling.
- The efficient number of patrols represents the sum of the number of patrols each prospective supplier team bid in the auction.
- Each prospective supplier team was offered the number of patrols they each bid at the efficient price (self-selection).
- Low cost supplier teams were offered more patrols than high cost suppliers.

## 5.4 Calculating aggregate payment from buyers

- The aggregate payment from buyers is calculated by multiplying the efficient quantity of input with the efficient price per unit of input.
- In case of more than one buyer group the aggregate payment is split between buyer groups using their respective implicit prices as weights.

### Our PES schemes

- The aggregate payment from buyers was calculated by multiplying the efficient number of patrols with the efficient price per patrol.
- The aggregate buyer payment was split between the two buyer groups using their respective implicit prices as weights:
  - International tourists visiting Lao PDR
  - Urban residents of Vientiane City
- Payment per buyer within each buyer group was calculated by dividing their respective aggregate payment by their respective buyer populations.

## 5.5 Contracting

- Suppliers are linked with buyers through contracts.
- Buyers are ‘contracted’ through a payment vehicle that makes payments obligatory.
- Individual supplier contracts are signed by the agents (on behalf of the buyers) and the suppliers.
- Contract compliance on the part of both suppliers and agents is crucial for a PES scheme to be effective and efficient.
- Core contract elements include:
  - Definition of terms
  - Contract term
  - Definition of service (inputs) delivered by the suppliers
  - Type of returns to suppliers
  - Terms of payment
  - Definition of penalties for breaching contractual obligations
  - Definition of mechanism for grievance, conflict resolution and redress

### Our PES schemes

- Individual patrol contracts were signed by patrol teams and the GoL.
- Village-level Community Conservation Agreements were signed by the respective communities and the GoL.
- Buyers were suggested to be ‘contracted’ through a compulsory levy for international tourists visiting Lao PDR and an electricity surcharge for the urban residents of Vientiane City.

## 5.6 Predicting PES scheme outcomes

- Outcomes are predicted using the bio-physical and economic models underpinning the PES scheme.
- Outcomes are quantified in terms of environmental service supply, the associated social net benefit and its distribution among buyers and suppliers quantified as consumer and producer surplus, respectively.
- Quantified outcomes provide a measurement of the effectiveness and efficiency of the PES scheme.
- Consumer and producer surplus measure the extent by which buyers and suppliers are made better off through their engagement in the PES scheme.
- Consumer surplus is calculated by subtracting the aggregate buyer payment from the benefits enjoyed by the buyers.
- Producer surplus is calculated by subtracting the costs of supply from the payments received by the suppliers.

### Our PES schemes

- The outcomes are quantified in terms of:
  - Extent of wildlife protection
  - Cost of patrolling
  - Benefit of patrolling
  - Social net benefit of patrolling
  - Surplus enjoyed by international tourists and urban residents of Vientiane City
  - Surplus enjoyed by patrol teams (and the broader communities)

## 5.7 References and materials

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- ❖ Policy Brief 4 'Project achievements and policy recommendations' (2017)

## 6. Assessment

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- An assessment of the PES scheme after the end of the contract term facilitates scheme adjustments prior to the next term.
- A set of indicators form the core for this assessment.
- Indicators to assess supplier performance include:
  - Patrol completion rate
  - Number of patrol team dropouts
  - Number of violations of the environmental code of conduct
  - Number of recognitions earned by patrol teams and communities
- Indicators to assess agent performance include:
  - Number and type of complaints received and solved through mechanism for grievances, conflict resolution and redress
  - Percentage of payments on schedule
  - Percentage of equipment delivery
  - Percentage of recognition delivery
  - Performance with respect to patrol scheme management
- Indicators to assess the performance of the bio-physical model include:
  - Accuracy of model input variables
  - Accuracy of assumed underlying functions
  - Accuracy of predictions