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Final report

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1 Acknowledgments

In honoured memory of Pak Henri Wira Perkasa
(b. 8-May-1974 d. 23-February-2023).

The project team wishes to acknowledge our skilful, intrepid, tireless Indonesian project leader Henri Perkasa. Henri is, and always will be, widely respected and remembered by the Indonesian development community, farmer groups, village leaders, and his Australian friends and academic colleagues for his professionalism and dedication to improving the welfare of rural society in Indonesia.

We appreciatively acknowledge the local Government officials, farmers, communities and all the stakeholders of Pagar Alam City, South Sumatra Province, Bandung and West Bandung Districts in West Java Province, and Merangin District in Jambi Province who collaborated, supported, contributed to and collaborated with the IndoGreen project activities. This broad partnership, cooperated and guided the many complex project activities, including the especially difficult COVID pandemic period. Together, we remain hopeful, our efforts deliver meaningful and lasting results.

2 Executive summary

Why the research was done?

The overall aim of *Agricultural Policy Research to Support Natural Resource Management in Indonesia's Upland Landscapes* (IndoGreen) was to provide advice to national and sub-national governments, village leaders and farmer groups on how policy interventions impact agricultural productivity, environmental outcomes and farm household welfare. To achieve these goals, the research focused on three upland catchments facing declining on-farm agricultural productivity and negative environmental outcomes for the wider catchment.

The project was motivated by the Indonesian government's concerns that existing land use policies and regulations contribute to soil erosion, soil nutrient loss, productivity declines, flooding, landslides, river and reservoir sedimentation and biodiversity loss. A second, equally important issue related to evidence suggesting that valuable agricultural extension and advisory services aimed at improving sustainable land use practices are adopted for only a few cropping seasons, before being abandoned by farm households.

What the research achieved?

In partnership with sub-national government officials, village leaders and farmer groups, the project team developed and tested four land-use decision planning tools, providing a rich understanding of how smallholder farming households respond to policy signals in the case study sites.

The land use planning models used the project's household survey data and local map data to provide a detailed understanding of how the current incentives and constraints faced by smallholder farmers shape and impact land use practices. The research provided insights on how households respond to changes in prices and to policy signals such as restrictions on their current land uses.

The land-use planning support tools present the economic, social and environmental trade-offs associated with land use changes resulting from alternative program interventions and policy scenarios. Key results include:

i. There has been significant land use change between 2012-2018 on the upland slopes. In general, there has been a transition where forest and agroforestry systems have been replaced with annual crops. Vegetable production provides the highest returns of production in the uplands, but a range of other factors influence land use decisions by households.

ii. Societal transformations are driving land use and land cover change across Indonesia. This rapid transformation presents farmers with new and highly profitable opportunities to participate in higher value fruit and vegetable chains and in domestic and export niche coffee markets.

iii. The land use changes shows that farming systems are dynamic and responsive to changes in prices and other factors such as population growth, expected yields and household preferences for agricultural production.

iv. Policies and programs are supporting rural road construction, providing several benefits that favour higher value seasonal crops over the soil-erosion reducing tree crops on sloping lands. The new roads save time, reduce transportation costs, reduce post-harvest damage, encourage crop diversification and provide easier access for both public and private advisory services to visit the farm plots.

v. No one policy is likely to result in both welfare increases and erosion reductions**.** Households own multiple plots, and they choose to allocate their household labour and capital across these plots. By responding to price premiums under a policy intervention, they can reallocate their resources to other plots and land uses.

vi. Erosion impacts are concentrated amongst a few households**.** The majority of erosion occurs from a smaller subset of plots and households. Policies should target those households and regions where the marginal cost of erosion abatement is lowest.

vii. Returns from mixed agroforestry are relatively low, and current policy and market incentives suggest these areas will decrease further without intervention. High upfront costs, long time horizons to realise cash income, and risks and uncertainty over future returns limit the benefits from timber for smallholder farmers.

viii. Interventions should consider the distributional consequences of policy options among households and gender consequences within households. The distributions of revenue, costs, and labour requirements demonstrate significant heterogeneity in outcomes for smallholder producers who otherwise grow the same crops in the same region.

What are the present and future impacts?

The project established a collaborative network of engaged sub-national government officials, village leaders and farmer groups dedicated to using the land use planning models to improve environmental and welfare outcomes.

The project produced land use planning tools, maps and household data sets. It delivered policy dialogues and training sessions that encouraged local policy changes and program initiatives that shift economic incentives in ways that improve agricultural productivity, reduce soil erosion and improve carbon storage.

The research demonstrated to the land use planners that it must be profitable for small farm households to adopt natural resource friendly crops and land use practices. The project strengthened the empirical knowledge base allowing better targeted interventions that can achieve greater and more equitable agricultural development.

The policy assessment and land use decision tools helped improve public investment choices at village and district levels, providing local and national policy makers access to the analytical skills that allows them to make better informed policy choices.

Among the off-farm benefits from improving land use practices include lower economic costs to communities due to lower sedimentation and flooding and lower organic and inorganic pollution leading to reduced water and soil contamination.

3 Background

The IndoGreen ACIAR project evolved from a two-day, national level Roundtable consultation in 2016. A key objective for the National Roundtable was to inform the Ministry of Agriculture (MoA), the Ministry of Environment and Forestry (MoEF), the Indonesian Agency for Agricultural Research and Development (IAARD) and the National Planning Agency (BAPANAS) on how to best address sustainability issues at the landscape scale for Indonesia's Green Growth Development Strategy.

The policy roundtable focused on three landscape types: (i) the lowland swamps and peatlands; (ii) the irrigated lowlands; and (iii) the mountainous uplands. One outcome of the roundtable was a request for ACIAR to support policy research for the upland landscapes.

A focal point for IAARD emerging from the Roundtable was the analytical and research gap explaining how national and local level policies shape farm household land use decisions. Much of Indonesia's past research focused attention primarily on the drivers of agricultural land expansion into forested areas rather than on how policies influence land management practices on existing plots within the forests. At the end of the Roundtable, IAARD initiated discussions with ACIAR to support a policy research project in upland landscapes.

A key output requested by the MoA from the 2016 Roundtable was to outline policy research priorities to support the NAWA CITA (The President's nine priorities for Indonesia).

During the project design phase, the IndoGreen partners addressed the key upland landscape issues highlighted at the Roundtable: (i) inappropriate crops and conservation practices on steeply sloping lands; (ii) unsatisfactory processes for designing and governing land management policies and programs; (iii) weak capacity and lack of support for using land use planning tools at sub-national levels; and (iv) a poor understanding of how existing polices and incentives influence crop choices and land management practices.

Five key issues motivated the project design. First, agriculture and agroforestry systems in upland landscapes have the potential to contribute significantly to national and local food availability and affordability, high value exports, rural incomes and jobs, and the overall livelihoods of rural communities.

Second, the economic impacts of not addressing Indonesia's land degradation are significant. There are some 48 million people in 32,000 villages living in and around forest boundaries, 10 million are categorised as poor (UNDP 2015).

Third, many of these households rely on upland landscapes for subsistence, livelihoods and economic development opportunities (World Bank 2015). Loss of agricultural productivity and ecosystem services leads to reduced incomes followed by increased poverty and food insecurity in a downward spiral and poverty trap. This process leads to increased deforestation as new land is brought into agriculture to make up for the lost productivity of the degraded lands.

Fourth, alignment with Indonesia's past and present agriculture and sustainability strategies outlined in its five-year development plan, the 2015-2019 RPJMN, were critical. IndoGreen aligned with the present National Development Plan RPJMN 2020–2024, with the policy framework and with Indonesia's higher level multinational commitments to Sustainable Development Goals, Climate Actions targets, and related treaties. IndoGreen research outputs support the RPJMN 2020-2024 climate-smart agriculture objectives, including transitioning land to lower-emission crops, improving water and land use efficiency and improving soil health.

Moreover, IndoGreen aligned with the Green Growth Program (GGP) supported by BAPPENAS and MoEF. The GGP aims to demonstrate how economic growth can be maintained while reducing poverty and inequality, maximising ecosystem services, reducing GHG emissions, and making communities, local economies and the environment resilient to economic and climate shocks.

Finally, the project specifically supports the RPJMN objective to use spatial planning to support environment sustainability by providing local and national land use planners with decision making tools to support more sustainable spatial planning. In addition, the research findings supported RPJMN strategies: (i) the adoption of sustainable approaches to farming on upland areas and (ii) increased adoption of environmentally friendly technologies for food crops.

INDOGREEN allowed policy makers to understand the relationship between past policies and land use and crop practices, alternative policies and land use and crop management practice decisions and the household income and environmental trade-offs associated with different policy choices.

This project's research activities produce outputs that fed into decision support tools, providing policy makers and program designers with a better understanding of how alternative policies and targeted programs influence farm household decisions that result in different crop and land management choices and the impact of those different choices on soil erosion, biodiversity, carbon and household welfare.

The University of Adelaide was the Commissioned Organisation. Australian partners include the University of New England and the Australian National University's Crawford School of Public Policy,. The lead Indonesia country partner was the Indonesian Center for Agricultural Socio Economic and Policy Studies (ICASEPS). The World Agroforestry Centre (ICRAF-Jakarta) and WWF-Indonesia were the two other core Indonesia partners. The project also involved the Indonesian Center for Agricultural Land Resources Research and Development (ICALRRD) and the Centre for Forestry Socio Economy, Policy and Climate Change under FOERDIA. Two regional universities collaborated closely with the project case study sites: Padjadjaran University and the University of Lampung.

3.1 The Three Upland Study Sites

The project team selected three upland study sites: (i) the Upper Citarum Catchment in Bandung and West Bandung Districts; West Java; (ii) the Pagar Alam District, South Sumatra; and (iii) the Merangin District, Jambi Province, Central Sumatra. The project collaborated with three existing development projects attempting to introduce improved agricultural practices to address externalities and improve natural resource outcomes in upland catchments. DANIDA and ICRAF had projects in the Pagar Alam District, South Sumatra; GEF, UNEP and WFF had activities in the Merangin District, Jambi and the World Bank in the Upper Citarum Catchment, West Java.

The three study sites represent three different levels of economic development. The West Java site represented households with long established rural communities with farm households managing multiple small plots in a region with active rental markets and access to state owned, monitored and well enforced tenure rules to forestry land for growing coffee. Due to population and land pressure, the communities in West Java experienced out migration.

In contrast, communities in the Pagar Alam study site faced less land pressure. The older agricultural areas were dominated with local, long-time native residents of Pagar Alam. In the past decade, seasonal migrants introduced vegetable production systems, especially cabbage which the today a recognised and prised cabbage production zone. Farmers in the cleared state forest lands are descendants of tea plantation workers from Java that migrated during the colonialization period and transmigrant groups from Central Java during the 1970s, and spontaneous migrants from West Java

More than half the farmland in the Merangin study site has been cleared in the past decade. Many new and unregistered migrants from South Sumatra and Java have arrived and cleared state owned farm land to produce vegetables, rice, coffee and oil palm on elevations below 800m. The unregistered population creates several problems for local governments trying to provide sufficient health, education and related fundamental services.

Data collection varied by study site. The biophysical information, includes data on soil types, slopes, land cover, water resources, population density, road networks (including measures of quality), location of markets, processing plants, relevant government services, and communication infrastructure. This data presents an important picture of the heterogeneity of the landscape, providing detailed information about where to target specific types of land use practices (eg, soil infiltration pits, vegetation strips, ridging between coffee trees).

The GoI, NGOs and international donors promote a range of development projects aimed at improving and sustaining agricultural productivity in the three catchment sites. However, all three sites lack sufficient household level socioeconomic data necessary to understand the role polices play in influencing household behaviour. Key collaborators in all three sites are willing to participate and share established community networks and biophysical data with this project.

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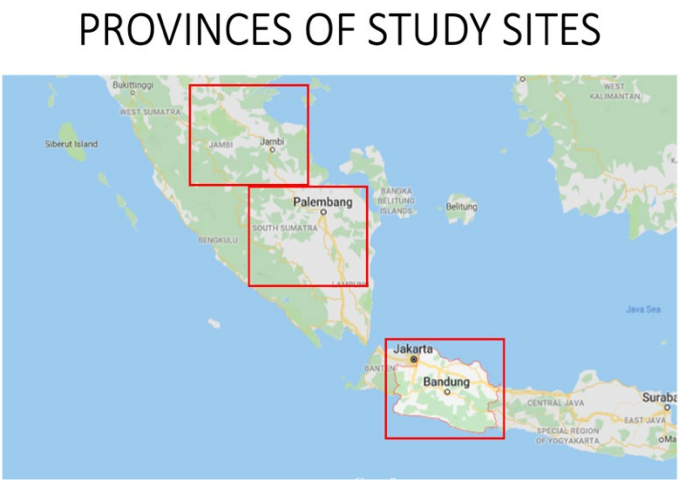
Bandung/West Bandung Study Site

The Upper Citarum Catchment in Bandung and West Bandung Districts of West Java represents an area with a relatively high level of economic development, with more established and complex farming systems than the Pagar Alam and Merangin study sites. The Upper Citarum site has a long history of farmer access to state owned/controlled forest land through leases. The area is a relatively densely populated landscape with much shorter access to high value urban markets, schools, and non-farm jobs.

The project team selected the Upper Citarum catchment site in large part due to its high visibility and importance to Jakarta as a water and power source. In 2018 President Joko Widodo passed Presidential Decree (15/2018) on 'Accelerating Pollution and Damage Control of the Citarum River' to revitalize the whole river. The Taskforce (SATGAS) Citarum Harum was formed to support the initiative, headed by the Governor of West Java.



Upper Citarum catchment studies show that, as the natural forest and vegetation is removed for agriculture, topsoil is gradually removed, and agricultural productivity deteriorates. Landslides and gullies reduce the productive land area further. The hydrologic regimes of the catchment rivers change, and flash floods and mudflows increase. The increased sediment load in rivers results in silting up of riverbeds, reservoirs, deltas and irrigation systems.

Pagar Alam Study Site

Pagar Alam District in South Sumatra represents a middle level of economic development relative to the Bandung/West Bandung site, with ever evolving, but less complex farming systems. Pagar Alam is in South Sumatra Province. About 70% of the population work as farmers and 40% of the total region is protected forests. Agricultural activities operate inside the forest boundaries, generating tensions and conflict between the state and the smallholders who are using the public forest resources to support their families.

An important opportunity for IndoGreen in the Pagar Alam study site is to influence two national level policy initiatives impacting land access and management for the local farmers. The programs are a Community Forestry (CF) initiative and an Irrigation Reservoir (IR) investment program.

The Ministry of Forestry and Environment, supervises the CF implementation in Pagar Alam, targeting around 1,000 farmers from 10 designated community groups and managing 4,000 hectares of degraded forestland. The community groups come from upland villages on the forest borders, with many group members still cultivating crops inside the protected forest boundaries. Other farmers have chosen to abandon their forest farming because of continuous tenurial conflicts with the state.

The IR program was part of the National Development Plan 2015-2019 to establish 65 new reservoirs to add 1 million Ha of irrigated cropping land. IR aimed to support national water security and food security goals, particularly to achieve national production targets for rice, maize, and soybeans. The reservoir construction for irrigation in Pagar Alam specifically aims to improve local rice production output and contribute to national self-sufficiency targets. Farmers in the designated area had to convert their agroforest land into irrigated rice fields.

The irrigation policy planned to convert 3,000 hectares of coffee agroforestry land to irrigated paddy fields, which equates to the loss of 40% of the existing regional coffee plantations. The reservoir construction is located on an upper stream of the Lematang Watershed, one of the largest catchment areas in Pagar Alam.

Merangin Study Site

Merangin District in Jambi, Central Sumatra represents a rapidly expanding agricultural catchment with forest clearing and high levels of new migrants. Merangin District contains a large area of pristine forest that protects the sub watersheds within the three subdistricts to be the centre of the IndoGreen project site: Lembah Masurai, Jangkat, and Jangkat Timur. Forest conversion to coffee, rubber, and cinnamon are increasing in these sub-districts. The data collected from village heads and migrant leaders suggest more than 10,000 unregistered migrant families are living in the study site. Merangin makes an important study site for the project as the provincial government is committed to a landscape management approach. Merangin is part of the five-corridor ecosystem named in Presidential Decree 13/2012 for the Sumatra Island Spatial Plan.

Merangin is also part of the RIMBA (Riau-Jambi-Sumatra Barat) Corridor that connects several conservation areas in Sumatra, including Kerinci Seblat and Bukit Tiga Puluh National Parks, which are critical habitats for the Sumatran Tiger, Sumatran Elephants and endangered birds. The RIMBA forest restoration targets critical land in the catchment to support green economic development.

The Merangin study site activities presented an important opportunity to influence the USD $50m Global Environmental Fund (GEF) project , RIMBA, under the auspices of the United Nations Environment Programme (UNEP) and WWF. During the final design phase of RIMBA in 2018, UNEP linked two of its project's objectives to IndoGreen project outputs: (i) proposing policies and programs to reduce forest clearing in a 4,000 ha buffer zone (assessing incentives for micro hydro) and (ii) seeking supporting sustainable agroforestry production systems through value chain initiatives.

4 Objectives

The project objectives are:

Objective 1. To estimate the socioeconomic and environmental impacts of national and local policies in three upland catchments.

Objective 1 contributes to the research strategy by examining the economic, social and environmental impacts of existing polices in each catchment study site. The research methods are designed to identify any key programs or policies influencing crop choices or land management practices of interest to farm households, farmer and women's groups, and local and national level policy makers. Next the research design tests how existing policies affect crop choices and adoption of conservation practices.

Objective 2. To estimate the socioeconomic and environmental impacts of alternative national and local policies influence socioeconomic wellbeing and environmental outcomes in three upland catchments.

Objective 2 estimates how alternative polices in each catchment study site could impact the economic, social and environmental outcomes. The results established under objective 1 is used to estimate the predict outcomes. The proposed policies to be tested include: (i) those under consideration by local and national governments, (ii) policies that appear to be the most significant barriers to improved land management practices identified in the analysis from Objective one; and (iii) the policies that appear to be most effective at encouraging land management practices that reduce negative off-farm impacts.

Objective 3. To assess the social, economic and environmental trade-offs and distributional consequences of alternative policies compared to existing policies.

Objective 3 establishes the socioeconomic and environmental trade-offs that are faced when a change from the existing policies to alternative policies is made. The information provided under Objective 3 will enable policy makers to understand better the economic, social, and environmental outcomes of policy changes. The ability of the policy changes to stimulate land use changes that result in improved environmental outcomes is a key point of analysis.

5 Methodology

The project's research strategy involves analysing how existing policies and programs shape farm level decisions and how those decisions impact economic and environmental outcomes. The research seeks to identify relevant and practical alternative policies that provide incentives for adopting land management practices to improve agricultural productivity and sustain the resource base.

The research draws on qualitative methods, including literature reviews, key informant surveys, policy dialogue workshops, focus groups and field visits to inform the household sample design and the survey questionnaire. Quantitative statistical, econometric and descriptive analysis of the household survey data are used to understand the determinants of land use decisions and the resulting socioeconomic and environmental impacts on those decisions.

Spatial maps containing biophysical and climatic data are collected for each study site to integrate with the household survey data, creating combined datasets to help understand spatial variations and land use choices made by diverse farm households. The applied econometric analysis and the biophysical and household modelling are used to create the linkages from: policy => household behaviour => catchment-level consequences.

We work with village leaders, farmer groups, district land use planners, government extension officers and farm households to identify relevant policy and program alternatives for testing. Land use scenarios are linked to the suggestions and objectives of stakeholders, existing land uses, and their objectives for land use changes, evaluating the economic and environmental consequences of the alternative land use scenarios.

5.1 Research Methods for Objective 1

To estimate the socioeconomic and environmental impacts of existing national and local policies in three upland catchments.

The theoretical basis for Objective 1 is utility maximisation by individual households. The research analyses the determinants of land use decisions and crop management choices by farm households.

The research goal is to quantify how conservation practices and land uses responds to policy signals and/or program interventions. Econometric analysis of primary household survey data is used to understand influences on land use decisions and the resulting socioeconomic and environmental impacts on those decisions. Biophysical and climatic data collected and integrated with the household survey data to create combined datasets to help understand spatial variations and farm household diversity.

The applied econometric analysis and the biophysical and household modelling are used to create the linkages from: policy/program => household behaviour => catchment-level consequences. Figure 5.1 illustrates the pathway from policy levers to economic, social and environmental outcomes. The linkages occur through changes in land-use practices. In general terms, the hypothesis is that policies/programs affect farmer behaviour, which in aggregate influences social, economic and environmental outcomes at the catchment level.

The heterogeneity occurs due to distance to markets, topography, climate, soil nutrients, erosion, land productivity, carbon stocks and other factors (Nkala et al 2011, Arslan et al 2015). A key feature of our method is that we consider spatial variation not only in those variables but also in household characteristics that ultimately determine the land-use patterns that develop over time. The catchment level effects of policies are then linked through the aggregate behaviour of households that react to policy variables.

Figure 5.2 summarises the methods, the data sources, and their connections. Primary household and village/community data are collected from the three study sites through household surveys and field work. Other primary data are obtained directly from each study site, where biophysical and environmental data are being collected by Indonesian project partners. Secondary data will be collected on institutional, geographical, climatic and other variables.

Household Surveys

The household data is the core input requirement for all three project objectives. The surveys provide data in a gender disaggregated framework. The socioeconomic household survey data of observed land use decisions by farm households provides the basis for the econometric modelling.

The questionnaires collect data on household demographics, family characteristics, details on land tenure, land use changes over time, soil and water practices, access to resources, all income sources, participation in government, NGO and local extension programs, and social, human and capital assets. The variables collected for each plot included area, slope, tenure status, irrigation status, current land use, use of soil and water conservation practices, main tree and crop species planted.

Additional field work insights and village level questionnaires relevant to the local situation are incorporated into our data bases based on meetings and interviews with community leaders and scientists. The research team secured research permissions, engagement, and feedback from the local communities and government agencies, identifying how the project can best address their own goals and development ambitions.

The project team met with and established relationships with the village leaders of the 23 randomly selected villages in the Pagar Alam catchment site and the 22 randomly selected villages in the districts of Bandung and West Bandung of the Upper Citarum catchment sites. The village leaders provide the most accurate household population census the team needs for selecting households.

In April 2019, ICRAF supervised the 828 interviews with 414 households from the 23 villages in the Pagar Alam study site catchment. Interviews with both male and female heads of households and gender disaggregated data are key research activities. objectives.

By June 2019, the project team had prepared the survey sample for 1000 interviews with 500 households from 22 villages in the second study site, the Upper Citarum catchment, district of West Bandung and Bandung. ICASEPS supervised the Bandung/West Bandung survey from July to August 2019. The survey covered a total of 14 sub-districts and 22 villages. The structured questionnaire gathered information in separate interviews with male and female household heads, completing 900 interviews and collecting data on 1,233 plots containing trees and annual crops, and 1,601 observations for seasonal crops within those plots.

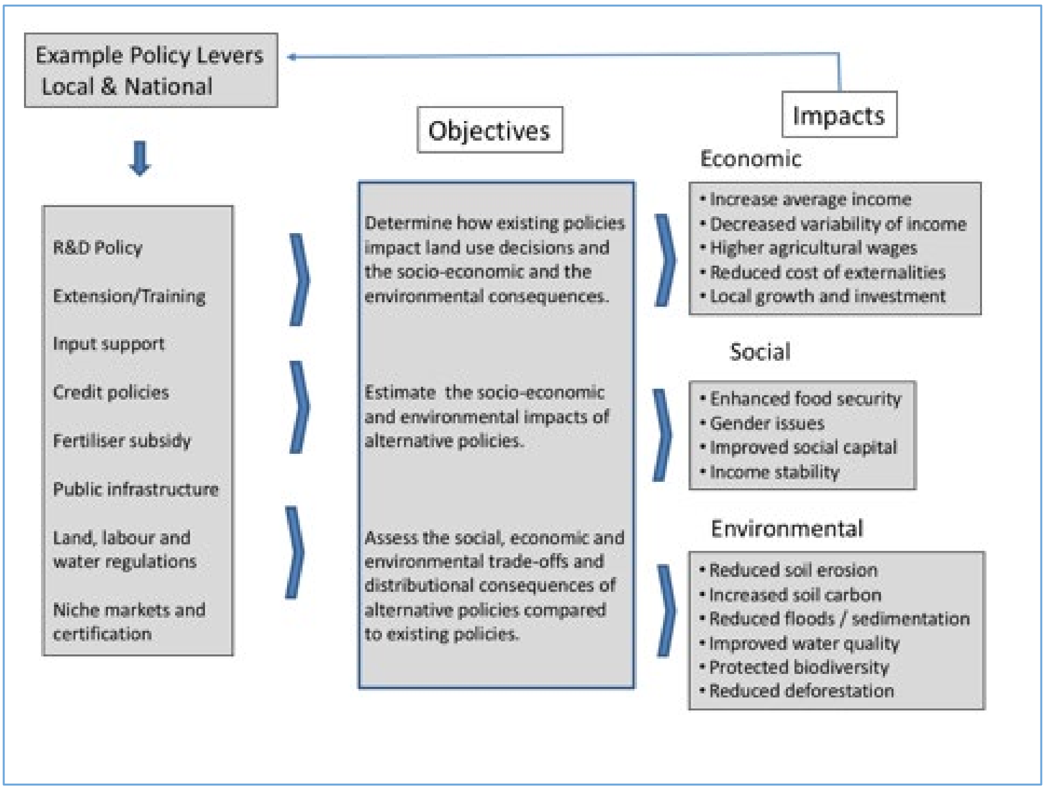
In this project, farm household survey data forms the basis of the *ex-post* econometric analyses for Objective 1 (see Figure 5.2). The team was unable to carry out the household survey in Merangin due to COVID.

In the Merangin study site, the project team prepared the background data and established the communication networks with the migrant communities to explain the purpose of the research and to gain their support and collaboration. Two challenging issues for preparing a random household sample in Merangin relate to the population sample and building a sense of trust with the migrant community leaders. Unlike the other two study sites, a full village census does not exist within the migrant communities. Migrants are often unable to register in their new villages until they are allowed to deregister in their old village.

To overcome the sampling issue, the team organised for a random sample of farm plots based on satellite data and maps. Using maps is more time and labour intensive due to gathering a full, accurate, up to date set up maps. The trust issue was successfully addressed by working through WWF and ICASEPS networks as well as through the local community's' relationship with Ranin Coffee. Ranin Coffee is the project's lead private sector collaborator in Bogor.

Through several meetings and workshops the team presented to the migrant leaders how the survey works, how the data would be used, including examples from the other two study sites. Covid delayed the survey two times (April 2020 and Sept 2020. In discussions with the project RPM in July 2021, the project team agrees that abandoning the household survey in the Merangin site is necessary and prudent.

Figure 5.1: Project Research Strategy



5.2 Research methods for Objective 2

To estimate the socioeconomic and environmental impacts of alternative policies in three upland catchments.

Objective 2 requires performing the *ex ante* policy analysis to predict changes in household behavior and to estimate impacts on household welfare and environmental outcomes at the catchment level.

The project teams developed three new models (IndoMod, IndoMap and KopiCrop) and adapted two existing models (FALLOW and GenRiver). The four models are used to fulfil Objective 2.1, but they also form the basis of analyses to address objectives 1.3, 2.2, 2.3 and 3.1.

IndoMod is an optimisation model developed and employed in the Bandung, West Java study site. At its centre is a set of heterogeneous farm households, each with an initial endowment of three resources: land (A), labour (L) and capital (K). Crucially, the land managed by a household is divided into one or more plots. Each plot is characterised by its area, slope, land use, position in space and other factors.

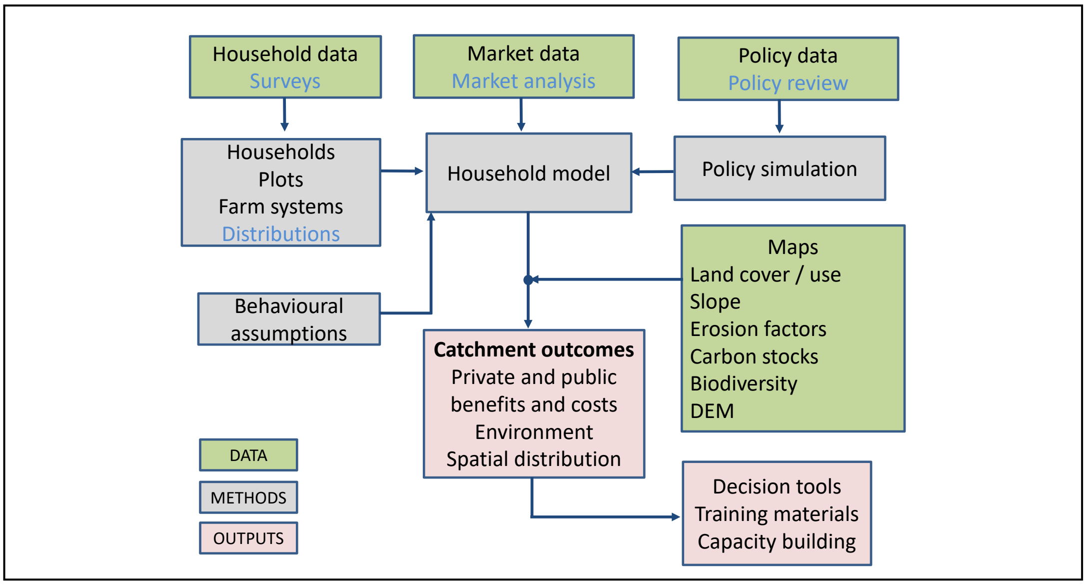
In addition to its resource endowment, each household is characterised by other variables including number of adult and dependent members, education level, use of conservation practices, and others. Households make land-use decisions based on farmer preferences and ability, price and costs signals, risk perceptions, resources available, and incentives provided by government.

The aggregate behaviour of households regarding land-use changes affects the landscape level. The land-use patterns that emerge have impacts not only on household welfare but also on environmental outcomes such as soil and water quality and biodiversity. The conceptual design of IndoMod is presented in Figure 5.2.

Different types of data are required to calibrate and run IndoMod. First, household data from the landscapes of interest (obtained through surveys) is needed to obtain a representative sample from which a population of households can be created. Second, several maps are required to represent the landscape on which the farmers are located. As a minimum, spatial data are required for land cover, and or land use, slope, and a set of erosion factors for the Revised Universal Soil Loss Equation (RUSLE).

Other inputs such as carbon, biodiversity and land productivity are desirable but not essential to run the model. Spatial input data is in the form of raster maps saved as tiff files. The other two types of data in Figure 5.2 (Market and Policy data) are less structured and they may come from several secondary sources depending on the type of scenario and intervention to be modelled.

Figure 5.2. Conceptual design of the IndoMod Model.



On the methods side in Figure 5.2, the household, plot and farm system data are analysed by looking at the full distributions of the key variables required in the model. This approach simplifies the process of moving from a sample to a population of households. The decisions a household makes are determined by its behavioural assumptions combined with information coming from policy simulations. Policy simulations may involve packages of interventions that provide incentives for certain actions (i.e. adopt agroforestry) and discourage others (i.e. forest clearing). The connection between farmer actions and landscape outcomes is created by overlaying households and their plots on the maps. Land-use changes on individual plots then determine changes in soil erosion, carbon and biodiversity at the landscape level.

On the outputs side in Figure 5.2, catchment outcomes are measured in terms of public and private benefits and costs. Key outcome measures include aggregate household welfare and its distribution, reductions in soil erosion and risk of landslides, reductions in carbon and biodiversity loss and others.

The applied econometric analysis conducted under Objective 1 provides the coefficient values to represent landholder behaviour in response to policy variables. Policy simulations can then be undertaken by testing household decisions under alternative policy packages. Spatial integration of household models, biophysical models and GIS data allows projections of catchment level outcomes to be made for any given policy package. These projections can then be used to quantify the socioeconomic and environmental trade-offs between alternative policies.

Mathematical programming (MP) is used to model household and farming systems. Household models of this type have a long history for *ex-ante* analysis in agricultural economics (Jones et al. 2016) and they can be solved using well-established software packages such as GAMS and Matlab. These features mean that the approach has high flexibility in representing the effects of policies, technologies and economic events on farmer decisions.

The MP approach has several advantages. These models allow:

(i) linkages between policy scenarios and farmer decisions to be represented through changes in prices, yields, technical coefficients and constraints;

(ii) new technologies can be represented through changes in technical coefficients that have a basis on scientific evidence; and

(iii) risk aversion as well as profit objectives to be incorporated in the decision model.

The FALLOW model is a spatially explicit landscape dynamics model that analyses drivers and consequences of land use change from the alternative policy packages on a yearly basis at the meso-scale. FALLOW is used for the Pagar Alam study site. The model has four core modules:

(i) plots with annual changes including crop yield, biomass growth, and soil fertility;

(ii) household information on staple food thresholds, food sufficiency and economic resources for farm families;

(iii) farmers' knowledge of productivity and expected yields; and

(iv) spatial prioritisation on the basis that farmers are rational and select the most suitable plots for clearing and planting based on their perception of plot attractiveness.

The policies to be tested in Objective 2 were selected based on consultation with national policymakers and with communities, district officers in the study sites. The linkages between policies and the *ex-ante* farm-system model can be represented as changes in prices, yields, technical coefficients and constraints. This approach provides high flexibility for testing policy packages.

These decisions determine the location of land use changes at each time period. Activities related to agricultural land expansion disturb natural succession and soil fertility and affect the recovery process of cleared plots. The overall landscape dynamics leads to changes to ecosystem services, such as above-ground carbon stocks and biodiversity at the landscape level. Lusiana et al (2012) developed a livestock module to enhance the capacity of the model to assess trade-offs between different land sparing or sharing options on carbon sequestration and livelihoods.

Household actions in aggregate influence catchment outcomes. The FALLOW model takes the initial spatial pattern of land uses, then simulates landscape dynamics of the existing policies and the alternative policies through time. The FALLOW model estimates watershed functions, sediment loads, biodiversity outcomes, carbon stocks, soil fertility and other variables. Within Objective 2, we will adjust the household-behavior module of FALLOW to reflect the options and constraints faced by farmers in the study areas under alternative policy packages.

Participatory Research Activity

Objective 2 includes a participatory research component linking coffee farmers with high-value niche markets. This project activity introduced and assessed a market facilitation approach, testing how farmers reacted to incentives to meet higher value coffee production. The aim is to assess farmers' capacity and willingness to change land management practices in response to receiving premium prices for changing their coffee management regime.

5.3 Research methods for Objective 3

To assess the social, economic and environmental trade-offs and distributional consequences of alternative policies compared to existing policies.

Objective 1 provides a set of baseline household and environmental indicators for different farming systems and catchment locations under the existing policy settings. Objective 2 simulates the changes to farm household incomes, land use and environmental indicators based on the alternative policy scenarios of interest to local and national policymakers. Objective 3 then quantifies, compares, and analyses the trade-offs between the baseline outcomes and the alternative policy outcomes (counterfactuals).

Quantifying the differences allows policymakers to visualise and recognise the key economic, social, and environmental trade-offs that arise given a change from existing to alternative policies. Because the econometric models are estimated with farm level data, the policy simulation results can be displayed as maps for District and village planners to identify preferred options for specific catchment areas.

The trade-off tools form the basis of the training materials to be designed for capacity building. The household data, biophysical data, models and training materials are the core decision support tools. These outputs will provide important tools for policy engagement, with strong visual appeal, allowing local and district officials to support their policy proposals.

6 Achievements against activities and outputs/milestones

6.1 Objective 1: Estimate the socioeconomic and environmental impacts of existing national and local policies in three upland catchments.

	Activity	*Outputs/milestones*	*Bandung/West Bandung Comments*	*Pagar Alam Comments*	*Merangin Comments*
1.1	***Establish the policy context, institutional settings, environmental issues and socioeconomic profile in the three upland catchment study sites.***				
1.1(a)	Inception workshop: design study site assessment plan, collaboration with related ACIAR projects, elaborate work schedule, confirm responsibilities and initial policy dialogue/engagement	Project held Inception workshop in Bogor in January 2018. Four-member Advisory Board established in November 2017. All four attended the inception workshop. Workplan for overall project and each of the three sites discussed at	. Inventory list of existing secondary data and data gaps (reports, gps maps, etc.) required to establish policy setting and modelling requirements each up for each study site. (See Sections 10.2 and Section 11.1 for links to publications, data and videos)		

	meetings at the national level.	finalised following inceptions workshop.			
1.1(b)	Initial visits with official introductory letters, conduct assessments, establish networks with local universities, initiate policy dialogue/engagement and introduce concept of decision support tools to district officials.	Inventory listing key policy issues important to district and village leaders. (The policy inventory is updated over time). Initial secondary data and reports inventory completed in July 2018 (with updates, ongoing updates. Database of key local stakeholders' emails and phone numbers for focus groups and related qualitative research to establish policy settings.	**Bandung** Initial field visits to Bandung sites, district offices, Provincial land planning departments -district agencies in June to September 2018. Introduced the project to the local government, established contacts and networks for longer term engagement. Initial field visits to district offices and local villages completed, establishing main contacts for land use planning and policy dialogue network. Introduced IBP (Bogor), University of Indonesia (Jakarta) and Padjadjaran University (Bandung) to the project.	**Pagar Alam** Courtesy and engagement visits to Pagar Alam began in February 2018, directly following the inception workshop. ICRAF organised and presented a series of introductory meetings with farmer groups, the new Mayor of Pagar Alam, key coffee traders, women's and farmer groups.	**Merangin** The WWF team-initiated visits and project introduction to local groups in March and in Aug 2018.The first meeting was hosted by the local land planning office and introduction of the project to other local government and offices.
1.1(c)	Document and review past and present policy and project interventions in the study sites, develop linkages with key existing ACIAR	Background papers documenting the existing literature with key past and present policy and project	Identifying present and past development and research programs on land use evaluations were carried out jointly by the team following a similar qualitative methodology, with literature reviews and key informant interviews. Project team carried out in-depth interviews with Provincial, districts and local government officials, farmer groups, and village leaders to assess local NGO and government initiatives.		

<table>
<tr><td></td><td>projects, and focus on policy and program interventions targeting women.</td><td>interventions in the study sites.
Project produced 4 background papers presenting key past policy initiatives at the national level (see Annex 1: Mapping papers to activities)</td><td colspan="3">The gender issues were guided by a PhD student at UA and the Head of Rural Gender Studies at the University of Indonesia, Prof Mia Siscawati, who is member of the project’s advisory group.
The project team met with local academics in Bogor, Bandung, South Sumatra and Jambi to assess past/ongoing land use studies and gender studies.
The research team set up links (referred to as policy dialogue platforms) to communicate with government offices, farmer groups catchment boards, etc.
The assessment of activity 1.1(c) for all 3 study sites are presented workshop presentations and in the 4 Background Papers listed in Section 10.2, the list of Project publications.</td></tr>
<tr><td>1.1(d)</td><td>Engage at national level with MoA, OECD policy team, BAPENAS to collect and analyse relevant national level policy data.</td><td>Meeting minutes are Communication with the national level agriculture and forestry policy community began during project development and is periodically updated through government networks with ICASEPS, ICRAF, WWF.
Covid resulted in zoom and phone calls for policy dialogues beginning in April 2020.</td><td>Bandung
ICASEPS carried out a series of introductory meetings with national agencies and international agencies for all project partners in June 2018.</td><td>Pagar Alam
ICASEPS carried out a series of introductory meetings with national agencies and international agencies for all project partners in June 2018.

ICRAF communicated the project activities via its networks, focusing on BAPENAS and the Green Growth Strategy for the project.</td><td>Merangin
ICASEPS carried out a series of introductory meetings with national agencies and international agencies for all project partners in June 2018.</td></tr>
<tr><td>1.1(e)</td><td>Coordinating secondary data collection on district and village information on, inter alia, public infrastructure</td><td>Project team established a databank required for sample design, surveys instrument design and analysis. Initially set up on Drop Box in March</td><td colspan="3">All activities completed for all 3 study sites, with village-level data files organised in xls files in Bahasa and key data translated into English for all study sites.
In addition to the government village data, a questionnaire was designed for the village that captures IndoGreen-specific data needs, e.g., current farm household population, local investments for rural and agricultural roads and training facilities.</td></tr>
</table>

	spending, village assets, women's groups, extension services, input policies, local farmer groups, organisations, market structures, village population, recent natural disasters, agricultural and commercial profile, tenure and property rights to land, water and labour, climate data on rainfall, GPS and biophysical data.	2018, then shifted to Goggle Drive in Dec 2019.	We gathered relevant data from the Village Potential Statistics (PODES) dataset which provides information about village/desa characteristics for Indonesian villages. PODES does not cover our villages, but we used their indexes to gather our own data sets. We gathered data for the randomly selected villages in the Upper Citarum Catchment and Pagar Alam. Due to Covid we did not do a randomly selected village sample in Merangin, but WWF completed data collection of agriculture, infrastructure and other variables for all the Merangin site villaes in 2019. Meeting reports, workshop outcomes, all ppt presentations and zoom meetings are recorded and placed in the Project's Google Drive.		
1.1(f)	Assess all information from Activity 1 and prioritise existing policy options to inform Activity 1.2 tasks.	Workshops to assess all information from Activity 1 and key policy options are prioritised.	**Bandung** The analysis and methods are adaptable to shifting national and local policy priorities. Results published in meeting reports (Bahasa) and summaries in English. Inventory of policy options published.	**Pagar Alam** Relevant policy options are published in ICRAF manuscript presented in Annex 1. Unlike the other sites, Pagar Alam site faces two specific national level interventions that were just beginning when the project started: the national government irrigation reservoir expansion, and the community forestry initiative.	**Merangin** Completed in August 2019. Workshop with UNE, UA and WWF and relevant local authorities held in August 2019.
1.2	**Evaluate how existing policies affect individual**				

	household land use decisions and the socioeconomic impacts of those decisions.				
1.2(a)	Identify key policy and regulatory issues facing farmers’ groups, cooperatives, women’s groups, farmers, village leaders, traders, and district-level officers, NGOs and others (three study sites over eight weeks).	Focus group reports based on semi-structured interviews	Completed. Focus group, key informant interviews and meeting reports in Bahasa with summaries in English. June to September 2018 for the initial engagement phase. Farmer groups, women’s groups, coffee cooperatives, village leaders, local NGOs, catchment board.	Key-informant interviews undertaken from March to September 2018 with 23 local government officials, irrigation contractors, local farmer leaders, and other actors in coffee value-chains. A series of focus group discussion from 10-19 September 2018, with groups of male and female smallholders in eight villages impacted by the policies. Each group consisted of 10 to 14 smallholders, leading to 16 focus group discussions participated by 172 female and male smallholder farmers in total.	A series of focus group discussions with local government planning office, migrant community leaders, village heads and local district water services, and farm groups and women farm groups conducted in Merangin District Jan 2019.
1.2 (b)	Use study site data from Activity 1 to prepare household survey sample design and initial draft questionnaire for pretesting.	Draft questionnaire	Survey design and survey instrument completed in January 2019 with results presented in a project brief.	Survey design and survey instrument completed in October 2018, with results presented in project brief and ICRAF manuscript.	The project team pursued field work and workshops with migrant leaders to gain their support for the IndoGreen site. Sample survey design, questionnaire development and tablet entry completed

					in August 2020 with support of the migrant community leaders. The results presented in project brief. The team completed the work during the first year of the pandemic in hopes access before mid 2021.
1.2 (c)	Design stratified random samples in each study site to capture the biophysical, policy and household diversity.	List of households and addresses for interviewing.	Final list persented and discussed in January 2019 and finalised in April 2019. Results presented in project briefs.	Draft completed in November 2018 with results presented, discussed and and finalised at the project's annual workshop in Januayr 2019. A project brief presents design details..	Completed in August 2020, with results presented in project brief.
1.2 (d)	Revise questionnaire to identify and policy links between their decisions and natural resource governance processes, village customs and public spending (roads, irrigation, extension services, infrastructure).	Revised questionnaire for enumerator training and final testing.	Questionnaire tested, revised and completed and pretesting training completed in Comcare tablet September 2020.	Questionnaire revised and completed and pretesting training completed in tablet March 2019.	Questionnaire completed and entered into Comcare tablet September 2020. We were unable to test the questionnaire due to Covid.
1.2 (e)	Prepare programs for 'tablet survey', enumerator training, final pretesting.	Questionnaire transferred to tablets.	Completed in June 2019.	ComCare tablet final version ready in March 2019.	Tablet prepared but interviews abandoned due to Covid in January 2021.

1.2 (f)	Undertake survey of male and female heads in each household.	Surveys of male and female heads in each household.	Completed in late August 2019, 1000, interviews with both the male and female heads of 500 households from 23 randomly selected villages in the Upper Citarum Catchment.	Completed in April 2019, the household survey was conducted with more 800 male and female heads of 417 farm households from 22 randomly selected villages in Pagar Alam	Abandoned due to Covid.
1.2 (g)	Econometric analysis to test hypotheses.	Report assessing the ex-post policy impacts on socioeconomic impacts This will allow us to characterise the household models based on the population of farmers represented in the data.	Two published journal articles, five project briefs, and ten working paper publications to date assessing drivers of land use transitions and farm use of soil and water conservation.	Two published journal articles, one journal article under review, six project briefs, one working paper, and two manuscripts to date assessing drivers of land use transitions and farm use of soil and water conservation.	*Abandoned due to Covid.*
1.2 (h)	Engage with local and national policy community to share progress and initial results, including current questionnaire and survey stages and incorporate feedback.	Workshop/policy forum reports.	ICASEPS organised 3 formal policy dialogue session with local networks to present work, including the Upper Citarum Catchment Management Board. The team engaged with the broader academic and national policy community at two conferences in 2021, presenting five papers. The team used zoom and WhatsApp during the Covid lock down period.	Project engagement workshop presentation at local university in Pagar Alam by University of Adelaide project staff on climate change and environmental issues. Survey data presented and shared with district offices.	Not applicable.

			Face to face engagement with local community leaders began again in March 2022.		
1.3	**Establish the connection between existing policies, farm-level decisions and off-farm impacts in each case site.**				
1.3 (a)	Collect data and information required for the biophysical modeling at the catchment level.	Data for biophysical and catchment modelling.	The project team collected the necessary biophysical data to manage the three land use decision support models for the Upper Citarum Catchment. The team continues to gather and validate additional information and data to enhance the model's value.	Profitability survey of representative households in Pagar Alam July 2019. The representative plot data is required for the Fallow Model. The biophysical maps are in place.	The project team moved forward gathering land cover, carbon, soil and water quality data embedded in maps in an effort to assess land use changes without the household data.
1.3 (b)	Establish the connection between existing policies, on-farm-level decisions, and downstream impacts in each study site.	Representative household models for policy analysis. Key farming systems selected to represent catchment management issues. Coefficient values to represent landholder	The project team completed the work preparing the GenRiver model and initiated policy scenarios with trade-off outcomes. Adapted modules to GenRiver to support policy questions. Scenario analysis based on the various land covers combined with changes in	The results of one qualitative study for this activity in Pagar Alam are published in the Journal Land Use Policy and presented at the Ecosummit Conference organised by Elsevier. A second qualitative study has been published by the PhD student in the journal Agriculture and Human Values.	Not possible for Merangin.

		behaviour in response to policy variables. Model with households, biophysical and GIS data integrated.	rainfall due to climate change are explored, to test the range of effect of hydrological functions.	A third study by the PhD student under review in Forest Policy and Economics. Two manuscripts and one Working paper assess the linkages.	
1.3 (c)	Adapt FALLOW model (and site-specific models) to estimate key environmental services in each site using biophysical and household data (spatial integration).	Calibrated spatial model for policy analysis and environmental outcomes at catchment scale. Reports providing environmental outcomes of existing policies at catchment level.	The Bandung sited dropped the FALLOW model (not appropriate for the Bandung landscape due to the built up, urban settlements. There are insufficient rural areas for FALLOW to measure). The coding of data is completed for the IndoMod, the household optimisation model. IndoMod was developed specifically for the Upper Citarum Catchment stie. IndoMod incorporates the household data, integrating this data to show income impacts on households and soil erosion and carbon outcomes from alternative policy and program initiatives Maps for the Upper Citarum site are located for IndoMap, a second model, solely a map-based model assessing land cover	The FALLOW model is adapted to the Pagar Alam landscape and incorporates plot level data from the profitability study using representative households. The Fallow model can show trade-off between plot income and soil erosion and carbon. Two manuscripts present the results of the Fallow model.	The Merangin site gathered water quality and carbon capture maps to use in scenario-based assessments of land cover change.

			changes over time, without integrating the household survey data developed specifically for the Upper Citarum Catchment stie. Data is organised to produce a third xls-based model, KopiMod, developed using the household data. KopiMod is more assessable and shows the outcomes of crop choices on soil erosion and farm income. KopiMod is aimed at the village level and farmer groups.		

6.2 Objective 2: Estimate the socioeconomic and environmental impacts of alternative policies in three upland catchments.

	Activity	*Outputs*	*Bandung Site*	*Pagar Alam*	*Merangin*
2.1	**Design and calibrate farming-system model for analysis.**				
2.1(a)	Design a generic mathematical programming model of the farming system. that relates policy variables, technical coefficients, prices and yields to the decisions made by risk-averse farmers.	Farming system model capable of assessing alternative policy impacts on natural resources for environmental impacts is operational.	The appropriate variables and coefficients are identified, located and validated for IndoMod. The GenRiver, IndoMap and KopiMod are not generic mathematical programming models, but are developed in response to needs and requests from the policy dialogue platforms.	The Fallow Model is not a generic mathematical programming model but has the capacity to meet Obj 2 and Obj 3. for Pagar Alam.	Not Applicable
2.1 (b)	Produce the baseline farming system with representative farm households and spatial patterns for ex ante analysis in each catchment.	Farming-system model calibrated for policy analysis.	The three models are calibrated, reviewed with local policy dialogue team and experts then revised for the Upper Citarum Catchment. The baseline established.	The Fallow model baseline established.	*Not Applicable*

2.1 (c)	Define linkages between policy scenarios and household models.		Six relevant policy scenarios identified. Two project briefs detail the six policy scenarios identified with input from the policy dialogue platform group.	Four policy scenarios identified. Policy Brief highlights and justifies the four choices.	Not applicable.
2.2	**Estimate economic impacts of alternative policies on farm households.**				
2.2 (a)	Produce baseline policy scenarios to the representative farming systems	Report determining the effects of location on land use decisions and how alternative policies change outcomes.	A report on catchment modelling in Upper Citarum watershed is published based on the use of GenRiver model assessing the hydrological function given the current land cover and rainfall for the next 20 years. The IndoMod, IndoMap and KopiMod for the Upper Citarum Catchment models are calibrated and running scenarios from August 2022. Project Briefs and working papers are published and a training package on how to build, adapt and use the models are in draft form to be completed in February 2023.	A study on the impact of sustainable agriculture strategies on farmers livelihood and carbon sequestration in Pagar Alam produced.	*Not applicable.*
2.2 (b)	Produce a household model to estimate the socioeconomic and	A working household models.	INDOMOD and KopiMod models incorporate household data. KopiMod	Fallow integrates plot data from representative household sample.	Not applicable.

	land use outcomes of alternative policies.		works at the individual household level. IndoMod works at multiple levels: the aggregate household, to clusters to individual across the catchment.		
2.2 (c)	Estimate expected profits and risks experienced by farmers under alternative policies.	Reports providing economic outcomes from alternative policies	IndoMap and IndoMod produce profit and environmental outcomes for the six scenarios. Risk profiles are being adapted for additional runs.	FALLOW produces results for the four scenarios across the Pagar Alam Catchment.	*Not applicable.*
2.3	**Evaluate how existing policies affect individual household land use decisions and the socioeconomic impacts of those decisions.**				
2.3 (a)	Overlay farm-system results with map layers at catchment scale.	Report assessing at the catchment-scale impacts of alternative policies.	Maps integrated to create the IndoMap and IndoMod models. Two manuscripts showing impacts of six alternative policies and outcomes across the landscape for soil erosion and carbon and household income.	Fallow Model produces environmental outcomes and trade-offs on plot profit, showing outcomes in spatial and temporal space.	Not applicable.

			Outcomes and trade-offs are represented across the landscape and time.		
2.3 (b)	Establish the connections from policies to farmer behaviour to outcomes for alternative scenarios.	Study results of ex-ante analysis e.g., reports and summary briefs for policy decision makers.	Five working papers, four gender focused papers, two journal articles, eight project briefs and four gender focused project briefs produced on connections between household behavior and policies scenarios.	Three journal article, four working papers, and six project briefs produced on connections between household behaviour and policies scenarios.	*Not applicable.*
2.4	**Evaluate the economic, social and environmental impacts of a participatory research activity.**				
2.4 (a)	Design and initiate the alternative policy niche market experiment to link coffee farmers with high-value coffee roasters in exchange for adopting sustainable practices.	Design of an alternative policy program linking coffee farmers to niche market buyers.	All three study sites worked with coffee producers to discuss value chain opportunities, receiving higher payments for increased quality and premium prices for environmental practices like shade grown and agroforestry. However, the project planned and funded a value chain intervention for the Upper Citarum Site over a three-year period. The intervention included a baseline survey pre training and follow up surveys over the 3 years. Covid delayed the start of the intervention until March 2022 when both coffee and honeybee training were presented to two villages included in the study site. ICASEPS produced a short eight-minute video of the training program and followed up with the trainees over the following six months. An important outcome of the training was a grant for improved post-harvest processing equipment provided to one of the villages (several pulping machines, sorter and milling). The training activity helped to leverage the grant from the West Java provincial government.		

			ICRAF provided several training sessions for Robusta coffee growers in the Pagar Alam site.		
2.4 (b)	Produce baseline data for evaluation of participatory niche market coffee activity.	Baseline data for evaluation in year four.	The original baseline data and related value chain work is abandoned due to Covid. Video produced highlighting training outcomes. Reduced baseline of growers carried out in March 2022 with follow up in June and August 2022.	*Not applicable.*	*Not applicable.*
2.4 (c)	Evaluate results of niche market interventions by sampling participating households and evaluating aggregate impacts of their actions.	Evaluation of the economic and environmental outcomes.	Final evaluation report provided by ICASEPS.	*Not applicable.*	*Not applicable.*

6.3 Objective 3: Assess the social, economic and environmental trade-offs and distributional consequences of alternative policies compared to existing policies.

	Activity	*Outputs*	Bandung Site	Pagar Alam Site	Merangin Site
3.1	**Quantify, compare and analyse the socioeconomic and environmental trade-offs of existing policies.**				
3.1(a)	Analyse socioeconomic and environmental impacts of alternative policies to test trade-offs among key indicators.	Reports estimating the socioeconomic impacts and environmental impacts of alternative policy interventions compared with existing policies.	A manuscript is produced using six policy scenario impacts on soil erosion, carbon and household income. Two project briefs produced for policy scenarios. Three online videos recorded presenting the use of IndoMap and IndoMod. Two online videos recorded presenting the use and outcomes of from the KopiMod and how to use it.	FALLOW model examines impact of (i) reservoir establishment and (ii) community forestry and farmers capacity strengthening. Paper presented at Forest Trees and Agroforestry (FTA) International Science Conference in Nairobi, Kenya September 2020. A manuscript and a power-point presentation on FALLOW modelling with the scenario on social forestry policy and improving access to market of Robusta premium coffee is available.	Not applicable.

3.1 (b)	Analyse alternative policy priorities with national policy makers using trade-off analysis for catchments scaling up across multiple catchments. .	Reports economic, social, and environmental trade-offs associated with the implementation of alternative policy interventions identified by the national level government and stakeholders.	The GenRiver model produces impact assessments of soil erosion from alternative land cover and use management scenarios based on the current forestry and land policies. Presented to the Upper Citarum Catchment Board. The IndoMod and IndoMap scenario outcomes presented to the sub-national policy dialogue platform in February 2023 and to national policy makers again in February 2023.	Fallow model paper produced as part of ICRAF manuscript.	*Not applicable.*
3.2	**Generate policy advice and recommendations for national and district level decision makers**				
3.2 (a)	Final policy dialogue workshops with local level stakeholders to present trade-off analysis results.	Studies focusing on relevant empirical research for local policy makers.	Recommendations presented at the workshops above.	Two books and three posters targeted for sub-district audiences. The posters present the results of HH survey in Pagar Alam: smallholders' characteristics on socioeconomic and farming systems. Four policy briefs presented at policy dialogue sessions on (1) gender equity; (2)	Not applicable.

				dynamic s and vision of farmer's land use; (3) farmers' practices on soil and water conservation; (4) harvesting, post-harvesting and marketing of Robusta coffee.	
3.3 (b)	Final policy dialogue workshops with national level stakeholders to present CBA and trade-off analysis results.	Final policy dialogue workshops with national level stakeholders to present CBA and trade-off analysis results.	Presented in February 2023 to the national level policy community.		Not applicable.
3.2 (c)	Produce project briefs explaining the project’s tools and research outcomes.	Project briefs for dialogue with local and national decision makers and assessing the value of the decision support tools.	Project briefs are ongoing. The briefs will continue throughout the project.		
3.3	**Develop and support decision support tools**				
3.3 (a)	Local and national level agencies select staff to be trained using project’s decision support tools.	List of candidates identified for training.	Three training sessions carried with KopiMod in 2022. IndoMod materials and online. Presentations are prepared.	Fallow Model requires specialised capacity to use. No training planned.	Not applicable.

3.3 (b)	Establish capacities and skill gaps of staff selected for training in how to use the project's decision-support tools.	Evaluation of skill gaps and needs.	Capacity assessments for *KopiMod* from June to November 2022. Feedback on KopiMod is to develop a computer-based app.	Fallow Model requires specialised capacity to use.	Not applicable.
3.3 (c)	Develop and test training materials targeted to staff needs.	Technical reports and teaching materials to guide land use planning decision-making based on cost benefit and tradeoff analysis.	Three online training presentations created for IndoMod and IndoMap and two for KopiMod. Guidelines have been produced to run the GenRiver erosion module.	Fallow Model requires specialised capacity to use.	Not applicable.
3.3 (d)	Training workshops	Selected staff participants complete training.	A training workshop on Decision-Making Support Tools for the project's key partners (ICASEPS and FOERDIA). The aim was to show the capabilities of GenRiver model and to jointly develop model scenarios that reflect the current and possible future land and forest policies. The workshop also discussed modification that need to be included in the GenRiver model. The project organized an international training workshop on concepts and methods to evaluate ecosystem services on 18-20 February 2020. The training session was attended by participants from institutions across Indonesia, mainly members of EEI-Indonesia is a member of Economy and Environment Partnership for Southeast Asia (EEPSEA) and IndoGreen key partners, including from the District Office of Pagar Alam.		
	Final project review		January 2023.		

7 Key results and discussion

7.1 Key results and discussion for research question 1

To understand how existing policies shaped socioeconomic and environmental outcomes, the project team used a series of qualitative assessments (focus groups, key informant interviews and existing literature) and quantitative assessments (descriptive, statistical, and econometric analysis) of secondary data and the project's household survey data.

The following four sections discuss the project's results related to the socioeconomic consequences of existing policy and program in the upland study sites.

(i) How land uses changed over time;
(ii) The drivers of land use changes;
(iii) How farm profit relates to land uses and soil erosion risks; and
(iv) Conservation practices on farm household plots.

7.1.1 How land uses changed over time

Land use transitions in Bandung/West Bandung

The land use changes in the Bandung study site are from 500 male headed household and 442 female headed household (942 total respondents). The survey accounted for all plots managed by the family during the previous 12 months; the plots they owned as well as the plots they rented, sharecropped, borrowed, or leased from private individuals, village land or other government land, including leases inside protected forests.

Plots are small, with an average area of about 0.25 of a hectare, but there is variation, with 50% of plots at 0.14 hectares or less. Most farmers interviewed had more than one plot. The median is 3 plots per household.

Farmers were asked about the current land use of each of their plots (2019), as well as the land use when the plot was first acquired, and the plot use five years ago (2015). These data are used to calculate land use transitions that have occurred over time in the area.

The land-use transition matrix is presented in Figure 7.1. The *Total* column entries in the table represent the number of plots that were reported by farmers under each land use. The last column indicates the land use when plots were first acquired, and the last row indicates current land uses. (For greater detail and explanations of the Matrix in Figure 7.1 see the Upper Citarum Land Transition Project Brief).

For example, looking at coffee agroforestry, there were 19 plots when first acquired, compared with 67 plots currently (see blue arrows in Figure 7.1). Regarding coffee monoculture, there were 22 plots initially and there are 115 plots today (orange arrows). These results indicate a strong tendency by farmers in the region to move into coffee in recent years.

Vegetables are another crop that has increased in importance, from 412 plots initially to 531 plots today (black arrows). In contrast, the number of plots under rice, forest and tree crops have decreased.

The results in the matrix also show how many plots have remained in with the same crop since acquired, eg.14 plots remained in coffee agroforestry, 8 in coffee monoculture, 353 remained in vegetables. (These plots numbers are the shaded cells in the main diagonal).

Figure 7.1 Land use transitions in the West Java study site

Land use when plot was acquired	Current land use							
	Coffee agroforestry	Coffee monoculture	Vegetables	Rice paddy	Forest	Tree crops	Other	Total
Coffee agroforestry	14	2	2	0	0	1	0	19
Coffee monoculture	3	18	1	0	0	0	0	22
Vegetables	8	11	353	6	0	15	19	412
Rice paddy	4	3	57	384	0	3	6	457
Forest	18	36	23	0	1	2	12	92
Tree crops	13	31	35	1	0	44	2	126
Other	7	14	60	3	1	19	35	139
Total	67	115	531	394	2	84	74	1267

Interesting transitions include the conversion to vegetables from rice (57 plots) and from tree crops (35 plots). An obvious trend is that most original forest plots have been converted to other uses, leading to a reduction from 92 forest plots to only 2 at the time of the survey.

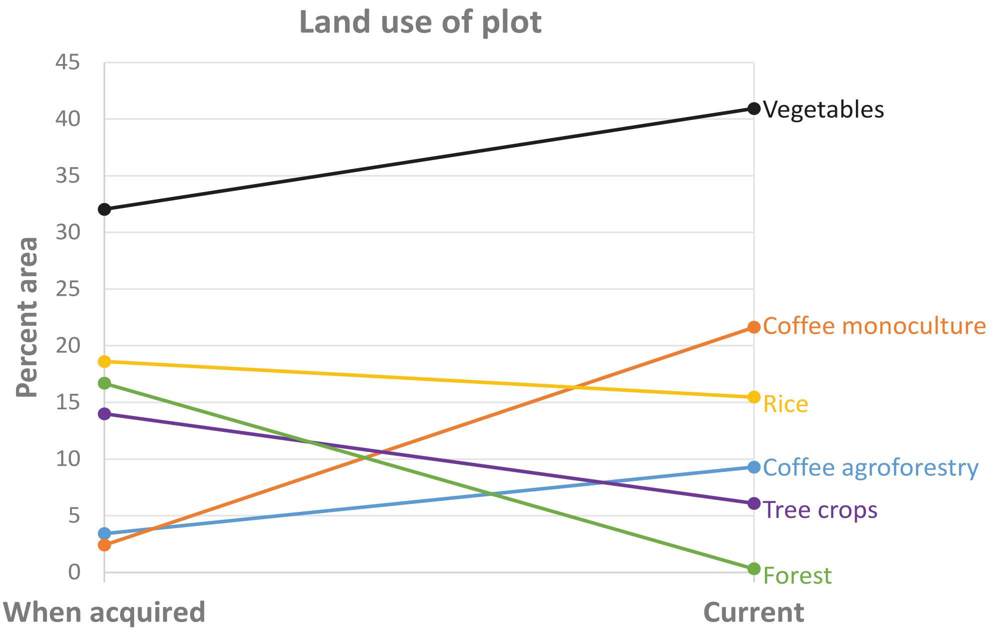
Upper Citarum Catchment Landscape

Figure 7.2 shows how these land-use transitions translate in terms of area. For example, the area of vegetables has increased from 32% to 41% of the total area of plots covered in the survey. Coffee monoculture has increased from 2% to 22%, and coffee agroforestry from 3% to 9%.

In terms of reductions, forest area decreased from 17% to virtually zero, and tree crops decreased from 14 to 6% of the area tree crops include rubber, fruit trees and trees grown for wood. There has been a small reduction in the rice area, from 19% to 15%, mostly caused by conversion to vegetables.

These trends in land-use transitions are driven by the profit expectations of farmers, combined with any policies or restrictions they may face at the local, regional, and national

Figure 7.2 Land use changes in the Bandung study site (percent area)



level. The resources available to farmers, such as land, labour, capital, knowledge, and availability of inputs (eg. fertiliser and improved seedlings) will also influence the land-use changes, observed. Data on some of these drivers have been collected in the project and will contribute to a better understanding of the relationships involved.

Land Use Transitions in Pagar Alam

The Pagar Alam study site provides data on 938 plots covering an area of 744 ha and managed by the 416 farming households in our survey. The plots had an average area of about 0.75 hectares, with 25% of plots at 1.0 ha or more. Most farmers interviewed had more than one plot, and like the Bandung study site, a median of 3 plots per household. The results of the land-use transitions are presented as a land-use transition matrix in Figure 7.3. (For greater detail and explanations of the Matrix in Figure 7.3 see the Pagar Alam Land Transition Project Brief).

Vegetable Plots in Pagar Alam

In Pagar Alam, coffee agroforestry shifted from a 167 plots in coffee agroforestry when they were first acquired to with 327 plots currently (see blue arrows in Figure 7.3).

Regarding coffee monoculture, there were 336 plots initially, decreasing slightly to 322 plots today (orange arrows). These results indicate a strong tendency by farmers in the region to move into coffee agroforestry in recent years.

Vegetables are another crop that has increased in importance, from 28 plots initially to 109 plots today (black arrows). In contrast, the number of plots under rice have decreased from 119 to 87, and the initial 29 forest plots were cleared, mostly to plant coffee.

Figure 7.3 show land-use changes with 75 plots converted from coffee monoculture, 6

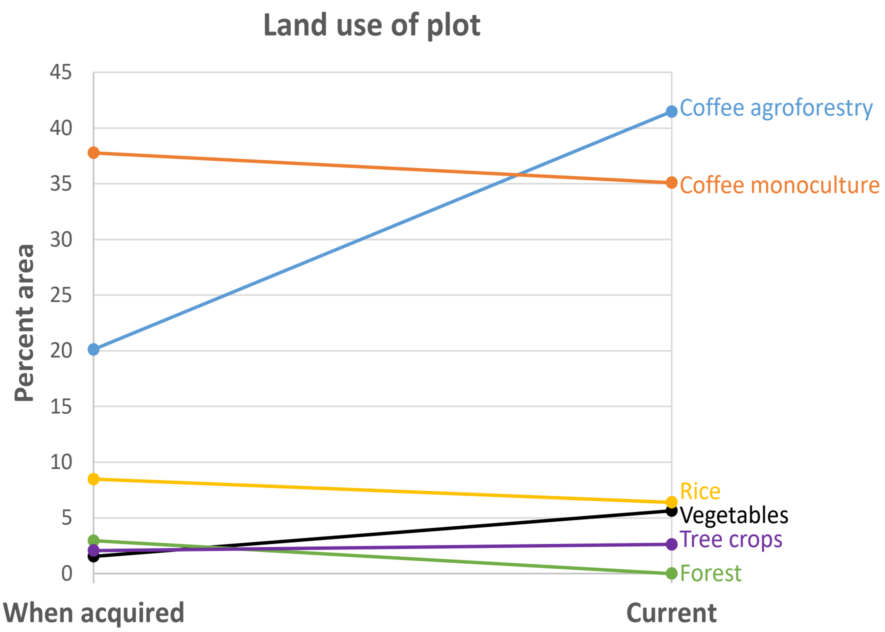
Figure 7.3 Land use transitions in the Pagar Alam study site

Land use when acquired	Current land use							
	Coffee agroforestry	Coffee monoculture	Vegetables	Rice paddy	Forest	Tree crops	Other	Total
Coffee agroforestry	152	7	6	1	0	1	0	167
Coffee monoculture	75	236	18	0	0	1	6	336
Vegetables	0	0	26	0	0	0	2	28
Rice paddy	6	3	24	83	0	0	3	119
Forest	15	9	1	0	0	0	4	29
Tree crops	0	2	2	0	0	12	0	16
Other	79	65	32	3	0	9	55	243
Total	327	322	109	87	0	23	70	938

converted from rice, 15 from forest, and 79 from other land uses. Other interesting transitions include the conversion from coffee monoculture (18 plots) and from rice (24 plots) to vegetables. An obvious trend is that all the original forest plots in the sample have been converted to other uses, leading to a reduction from 29 forest plots to zero today.

Figure 7.4 shows how these land-use transitions translate in terms of area. For example, coffee agroforestry has increased substantially, from 20 to 41% the total area of plots in the sample. The area of coffee monoculture has decreased slightly from 38 to 35%, and vegetables increased from 2 to 6% of the total area of plots covered in the survey.

Figure 7.4 Land use transitions in the Pagar Alam study site (percent area)



There has been a small reduction in rice area from 8% to 6%, mostly resulting from conversion to vegetables. This preference away from rice has implications for the national government's plan to increase irrigated paddy in the area. Finally, the area of tree crops increased slightly from 2% to 3% of the total area in the sample tree crops include rubber, fruit trees and trees grown for wood.

7.1.2 The drivers of land use changes

Anthropogenic activities and societal transformations are driving land use and land cover change across Indonesia. Urbanisation, population growth, economic development, rural migration, increasing incomes, shifts in diet preferences and an ever-expanding middle class are the major contributors to land use change.

Indonesia is the fourth most populated country on the planet, the largest economy in Southeast Asia, the only Southeast Asian member of the G-20, and the world's tenth largest economy (World Bank, 2019). The country's broader macro level policies resulted in an annual GDP growth rate of 5.6% over the past 50 years.

Urban populations increased from 50% in 2010 to 57% in 2020, adding more than 30 million to its cities and expanding the city scapes at the rate of 1.1% a year. Watch a Google Earth time lapse of Indonesian cities in Java or Sumatra and you view agricultural landscapes converting to urban uses and forested hillsides giving way to agricultural and agroforestry crops.

The middle class is growing faster than other groups, with 52 million economically secure Indonesians (World Bank, 2019). The emergence of the middle class has occurred within a single generation, expanding from 7% of the population in 2002 to more than 22% in 2018. The Indonesian middle class is driving societal transformation. The group's consumption has grown at 12% annually since 2002 and now represents close to half of all household consumption in Indonesia.

Importantly, for rural producers the sustained growth in living standards and expanding middle class contributes to an ever-increasing demand for higher value rural products. On average, 44% of middle class spending is on food purchases that is being shaped by diet diversification trends, increasing demand for fresh fruits and vegetables and higher standards of food quality and safety. Government estimates put Indonesia's average vegetable and fruit consumption (gram/capita/day) rising from 244.3g in 2019 to 316.3g in 2024 (World Bank, 2020).

Overall, annual per capita consumer spending on food has averaged more than 5% a year since 2010. This rapid transformation presents farmers with new and highly profitable opportunities to participate in higher value fruit and vegetable chains and in domestic and export niche coffee markets.

Agricultural sector policies tend to create mixed signals for producers. Indonesia's historical focus on supporting its strategic crops (rice, maize, sugar, soya and beef), offsets market driven opportunities for farm households to make higher profits producing value, higher crops.

With government spending to subsidise fertiliser, seeds, credit, and grants for equipment, price supports, and irrigation infrastructure focusing on the strategic crops, support for alternative crops is crowded out. These commodity-driven land conversion policies and programs are associated with high environmental costs from deforestation, forest degradation, and greenhouse gas (GHG) emissions.

On the other hand, sub-national agricultural policies and programs encouraged by village leaders and farmer groups, provide access to funding for local public good investments. For example, some programs for agricultural road development provide funds from the MoA of up to USD $9,500 for local rural and agricultural road construction sourced from the Special Allocation Fund for Agriculture (Maryati et. al. 2020).

During field visits to the Bandung/West Bandung study site, the study team observed numerous newly constructed rural, agricultural roads. Our interviews with village leaders confirmed the high priority the community and farmer groups place on local government using the village allotment of government funds to improve roads.

Agricultural and rural roads provide several benefits that favour higher value crops over staple the strategic crops. First, the time saving impacts allow quicker connections to local and regional markets for more perishable vegetables and fruits and improves access for value adding opportunities. Second, cost reductions result from fewer transportation exchanges (bicycles to motor bikes to carts to small trucks to larger trucks). In addition, cost savings result from less transportation induced crop damage, e.g. rough roads, heat exposure and frequency of handling. Third, new roads and better roads encourage crop diversification through access to more markets. Fourth, easier access for both public and private advisory services to visit the farm plots.

How farm profit relates to land uses and soil erosion risks This section firsts highlights project results linking farm income to land use transitions and, second, assesses the potential for the new land uses to impact soil erosion. We begin with the Bandung/West Bandung study site.

The analysis presented here demonstrates how designing alternative policies and/or advisory service programs and development projects for upland producers can be informed by evidence gathered from households about their farming systems. This section draws on several working papers and project briefs.

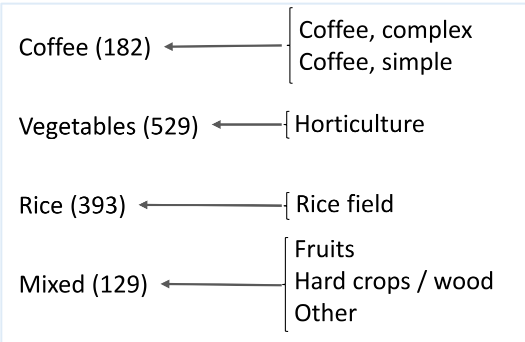
The analysis is based on the project's household survey of 499 farmers who manage a variety of seasonal and annual crops and trees. The farming systems in the Upper Citarum catchment are quite complex in general and the analysis is conducted at the land-use level. The original seven land uses in the dataset are aggregated into four: coffee agroforestry, vegetables, rice, and mixed trees and crops. We then estimate the expected revenues, costs and labour requirements for each land use.

In the first step, the plot and seasonal datasets are used to identify the land uses reported for all 1,233 plots managed by the 499 households (Table 7.1), then pooling into four land-use types for analysis (Figure 7.5).

Table 7.1. Land uses of plots in the West Java survey

	Land use	Number of plots	Percent
1	Coffee, complex intercropping	67	5.4%
2	Coffee, simple intercropping	115	9.3%
3	Horticulture	529	42.9%
4	Fruits	15	1.2%
5	Rice field	393	31.9%
6	Hard crops/wood	67	5.4%
7	other	47	3.8%
	Total	1,233	100%

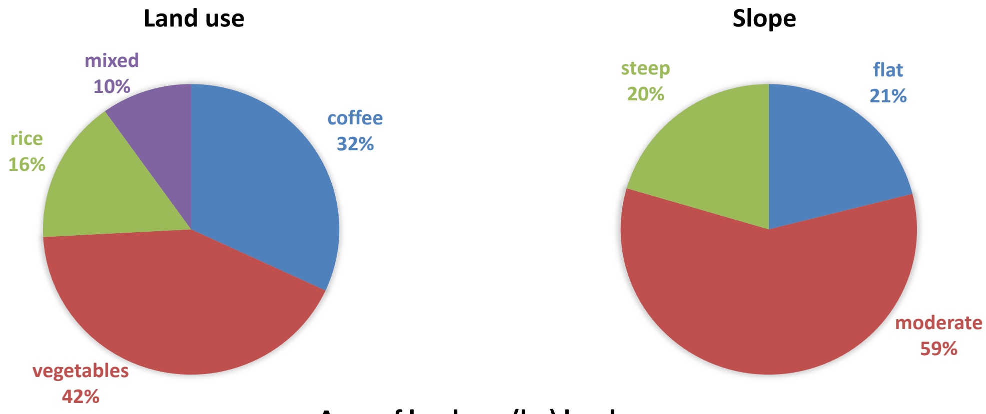
Figure 7.5. The four land-use types used with the number of observations in brackets.



Given those plots on relatively flatter slopes may also be of concern in vulnerable areas or high-risk soil types in the catchment.

Vegetables cover the largest proportion of the total area in the sample, with 42%, followed by coffee with 32%. In terms of slope, almost 60% of the area is moderate, with similar proportions of flat and steep land (20% and 21%). When split by slope, vegetables clearly dominate flat plots (37 ha), followed by rice (18 ha), and with a small proportion of coffee and mixed systems (bottom of Figure 7.6). In moderate and steep slopes, vegetables and coffee are the main land uses and they are evenly balanced in terms of area covered.

Figure 7.6. Distribution of plots in the sample according to land use area and slope.



Area of land use (ha) by slope

	Slope			
Land use	flat	moderate	steep	total
coffee	5.7	67.0	26.9	99.5
vegetables	37.2	68.5	26.0	131.7
rice	18.4	29.3	2.0	49.7
mixed	4.4	17.6	8.8	30.8
total	65.7	182.4	63.7	311.7

The next step in the analysis estimated inputs, outputs and profits for each land use. All variables are expressed on a per ha basis for consistency. Revenues and costs are measured in million IDR/ha and labour in pd/ha. The results were converted to a per-plot basis (based on plot area) when aggregated in the household analysis. These subsets of detailed data comprised 197 observations for tree plots and 824 observations for seasonal plots.

In the third and final step of the analysis, the plot-level results are merged with the household data (499 observations) according to land use and slope, to obtain the final dataset containing the key variables (net revenue, operating cost and total labour used) on a per-household basis.

The distribution of plots in terms of land use and slope is presented in Figure 7.6. Other variables related to the distribution of plots according to slope and land use (Table 6.2) provide insights into the farming systems in the area. The plots in general are small (~0.25 ha) and it takes the farmer ~20 minutes to reach the plot on average (using their usual means of transportation), but there are differences between slopes.

Plots on relatively flat land tend to be smaller on average (0.18 ha), and closer to the house (13 minutes) compared to plots on steep land (0.34 ha and 39 minutes), with moderate plots intermediate (0.27 ha and 19 minutes). In terms of land uses, the average plot area is virtually the same (~25 ha) for all land uses (Table 6.3), but the time to get to the plot from the house is shorter on average for rice (13 minutes) than for other land uses, suggesting that farmers like to plant their rice closer to home.

Table 7.2. Characteristics of plots in the sample according to slope and land use.

	Slope				Land use			
Variable	<15°	15°-30°	>30°		Coffee	Vegs.	Rice	Mixed
Mean area of plot (ha)	0.18	0.27	0.34		0.26	0.24	0.26	0.23
Distance to plot (min)	13	19	39		27	24	13	19
Number of plots	370	673	190		182	529	393	129
Number owned and operated	179	284	71		50	202	211	71
Owned as percent of total	48%	42%	38%		27%	38%	54%	55%

Table 7.3 presents the mean results, showing vegetables produce the highest net revenue (22.9 M IDR/ha) followed by mixed and coffee systems (9.4 M IDR/ha and 7.7 M IDR/ha respectively). The average net revenue for the rice system is negative (-9.5 M IDR/ha) because a high proportion of rice yields (~70%) are consumed at home rather than sold.

Vegetables also produce the highest return to labour (70,590 IDR/pd), followed by coffee and mixed systems (55,300 and 54,600 IDR/pd respectively). For reference, the average wage rate in the data is ~50,000 IDR/pd.

When the data are split by slope type (Table 6.3), the trends are consistent with those of the pooled data. Vegetables produce the highest net revenue, rice produces negative net revenue, and coffee and mixed systems produce intermediate levels of net revenue. However, there are differences between slopes.

Both coffee and vegetable systems have lower net revenue and require more labour on average in steep slopes compared to moderate slopes and to the pooled data. The labour input for coffee in flat slope did not follow the expected trend, with a higher value than in steep slopes, but this is based only on 8 observations and may not be reliable. Results suggests that coffee may not be a desirable activity on flat land.

Vegetables have higher expected net revenue and higher returns to labour than other land uses by considerable margins on all three slope types. This evidence helps explain why the area of vegetables has been growing in the study site, at the expense of rice and mixed systems and environmental outcomes.

Based on the mean results, vegetables are the best option in terms of expected profit and return to labour, but there are reasons why this land use may not be best in all cases. First, farmers tend to be risk averse, and vegetables exhibit higher variability of income than other land uses.

Second, farmers land-use decisions are constrained by labour and capital availability, and vegetables have the highest requirements for labour and the highest operating costs, which may limit the area of vegetables a farmer can run. Finally, land-use decisions may be influenced by food security concerns, with some households feeling a greater need to produce rice for their own consumption.

Table 7.3. Mean results from plot analysis.

Land use	Net revenue (M IDR/ha)	Labour input (pd/ha)	Return to labour (IDR/pd)	Operating Costs (M IDR/ha)	N
Pooled data					
coffee	.74	140	55,297	12.07	128
vegetables	721.92	311	70,586	45.41	251
rice	-9.48	288	-32,944	18.80	176
mixed	9.40	172	54,670	9.62	75
Relatively Flat slope					
coffee	7.49	258	29,039	6.77	8
vegetables	24.,69	314	78,653	10.64	72
rice	-8.82	251	-35,134	5.25	65
mixed	18.12	135	134,521	6.02	12
Moderate slope >15					
coffee	8.50	113	75,401	10.88	87
vegetables	21.84	292	74,715	44.94	134
rice	-10.74	320	-33,565	20.21	103
mixed	6.31	171	36,804	6.58	36
Steep slope >30					
coffee	3.70	163	22,825	9.05	31
vegetables	11.64	336	34,632	38.74	42
rice	-8.82	203	-43,555	14.82	10
mixed	5.71	167	34,088	9.99	24

7.1.3 Conservation practices on farm household plots

Encouraging SWC vs Land Use Cover

The next stage of our research workplan called for survey data analysis of Soil and Water Conservation?? (SWC) by farm households. Indonesia has a long history of promoting Integrated Pest Management (IPM) and SWC practices through its extension and advisory services. These programs aim to improve both farm financial and environmental sustainability. The extension programs emphasise the benefits of increased soil productivity outcomes (e.g., lower fertiliser costs) and improved water retention (better yields and crop resilience) offset the adoption costs.

The project's SWC research aims to understand factors that facilitate or impede the probability and extent of SWC adoption among smallholder farmers in our sample. Our analyses use the pooled multiple plot-level data from both study sites (850 households cultivating 2197 plots) and each project study site separately.

We examine both the plot level and the household level, evaluating the relative influence of policy and program variables that potentially shape farmers' adoption decisions: (i) their sources of information (social and agricultural networks); (ii) government extension and farmer-to-farmer extension; (iii) the nature and quality of information; (iv) farmers' climate risk perceptions; and (v) and their exposure to environmental shocks. At the plot level, we assess the *ex-post* impact of SWC practices implemented (i.e., the extent of adoption) and adoption of individual SWC on farm revenue.

We collected extensive household level data about household knowledge of SWC, the use of SWC in the past, and the use of SWC on each plot in the 12-month period prior to the survey interview. And we collected gender disaggregated data, gathering information regarding each male and female household head's participation in decisions to use SWC decisions and their role in implementing SWC activities. The specific SWC related questions included in the survey were refined and tailored to each study site through key informant interviews, multiple focus groups and a series of survey instrument pretests.

However, as the planning and data cleaning for the SWC analysis progressed, the team concluded that the Objective 2 modelling work should focus on alternative policy and program initiatives to promote land use and land cover change rather analysing polices to promote specific SWC practices. A second conclusion was to focus on the most vulnerable areas within the catchments, including slopes (>15^0), landscapes with high erosion danger levels, and those with high carbon, biodiversity potential.

Several reasons informed these decisions. First, the focus on land use and cover (i.e., crop choice) rather than SWC is guided by the body of research provided by Indonesian university and government research colleagues, documenting and mapping how soil erosion and nutrient levels respond to: (i) different land cover uses; (ii) SWC practices on different crops; and (iii) crop management and agronomic practices, including fertilizers and pest control methods.

Our field trips, mapping inventories, project workshop guidance from the Indonesian soil scientists along advise from village leaders, farm groups and forestry extension experts suggested the project team should concentrate policies and programs on appropriate and profitable agroforestry and perennial land cover systems on the steeply sloping and vulnerable areas within the landscapes.

Second, to build the survey instrument and to design relevant alternative policy initiatives for Objective 2, the project team gathered and assessed an extensive SWC literature to understand outcomes and effects on soil erosion, sedimentation, stream flows, carbon, biodiversity, and nutrient balance (eg., bench terraces, mulching, sediment pits, tillage, buns, strip grasses, contour ridging, etc). This literature compares the effectiveness and outcomes of specific land cover approaches like agroforestry, to engineering solutions like constructing terraces or establishing contour ridging.

Those of us on the project team who were not already aware, learned that land cover approaches like agroforestry systems are likely to prove more successful than establishing training programs or subsidising SWC practice adoption, especially for the engineering-based practices like terraces and contour ridging.

It turns out that humans rarely do anything about three causes of soil erosion: rainfall erosivity, soil erodibility, and slope steepness. The other three soil erosion causes are commonly addressed worldwide: slope length, cover vegetation and crop management practices.

The past fifty years of evidence examining Indonesia's programs addressing slope length, including terraces on steep slopes demonstrates rather strong rejection of terraces across all farm sizes, tenure types, education levels and income levels. The reason in Indonesia's context is that terraces are financially and time expensive to build and time expensive to maintain.

Because bench terraces are an engineering-based approach to soil erosion and water retention, they should be designed by professionals to increase the probability that they are effective. Empirical data documenting the labour-related establishment costs for proper terraces across Indonesia range from 50 to 600 labour days/ha, depending on the type of bench terrace and the slope length. Properly maintaining terrace risers also requires significant labour, from 130 to 210 labour days per year per ha.

Another potential disadvantage is that in some soil types, building terraces mixes higher quality topsoil with the lower nutrient levels in subsoils. Soil quality can also be harmed if fertilisers and pesticides more easily accumulate and concentrate because the terraces prolong infiltration time and build up storage levels. While many parts of Java and Bali have been successful, those areas represent only a small portion of country wide attempts.

The Bandung/West Bandung and the Pagar Alam study site surveys reveal that around 90% of the farmers who constructed terraces learned the techniques from neighbours or improvised on their own, without qualified guidance. Indonesian public funding and the international development community have subsidised terrace construction programs since the 1970s with little success. Project evaluations, at local, regional and national levels conclude that terraces present an unfavourable mix of benefits and costs to individual households.

Empirical evidence does demonstrate that when properly built and maintained, terraces reduce runoff, conserve water, weaken erosive forces, reduce sedimentation, increase yields, facilitate intensive agriculture and enhance soil fertility. However, improperly designed and maintained terraces produce negative impacts on water cycles, soil infiltration, rainwater collection and evapotranspiration.

Improperly designed terraces are common, resulting in gully erosion, riser collapse, additional runoff, and landslides. It is not uncommon for farmers to protect water-vulnerable crops like potatoes by cutting drains in the terraces to encourage fast runoff. In these cases, terraces can make erosion even worse. Field studies with careful observations over time report that, for many farmers, fast run-off is an intentional strategy used to protect water-vulnerable cash crops, for instance, potatoes.

Descriptive and analytical results on SWC practices

In this section we present descriptive data on SWC use; a synthesis of the key econometric analysis that assesses the impact of SWC practices on farm profit; and a list, with hyperlinks, of the core studies assessing SWC use.

Table 6.4 shows the adoption of individual SWC practices in the Pagar Alam study site are low for most practices. As noted above, terraces are uncommon. The majority who did use terraces either used information from neighbours or improvised the construction without professional guidance.

Raised beds in Pagar Alam

Column 2 shows the number of households who ever used a SWC practice any time in the past. And column 3 shows the number of households who used the practice during the past 12 months on any of their plots. The results highlight low use of SWC overall, and low motivation for using any practice for soil protection (Column 5), except for the terraces.

Raised beds are the most common SWC practice used among the Pagar Alam sample. A quarter of the respondents used raised bed on at least one of their plots in the previous 12 months. Only 17 households said that they use raised beds to prevent soil erosion, while 90 households said that the reason for them using beds is the ease of crop maintenance and harvesting as standing in the ditches next to the beds means quicker weeding, watering and picking.

Raised beds are common for horticulture crops in both study sites. The beds can protect against soil erosion when crops are grown along the slope's contour to minimize any water flow down the paths during high rainfall. Ideally, if the land is uneven, raised beds are constructed slightly off-contour to prevent possible ponding and overflow going across the beds and causing erosion.

Technical advice suggests that beds can be very effective at reducing soil erosion when properly built and used with slopes less than 15°**.** In the Pagar Alam sample, 77 of the 114 plots using raised beds had slopes of less 15°**.**

Table 7.4 Crop and SWC Practices from HH Survey Pagar Alam

Crop Management Practice	HH who has ever used the practice the (n=416)	HH used practice in the past 12 months (n=416)	% of total HH who used practice in past 12 months (n=416)	The HH's stated purpose is to prevent soil erosion (count)
SWC Practice				
Terracing	48	42	10%	38
Raised Beds	128	104	25%	17
Ditches	59	46	11%	4
Drainage	94	79	19%	6
Mulch	90	67	16%	4
Other crop practices				
Water storage irrigation	253	229	55%	0
Manure	173	171	41%	0
Compost	277	262	63%	0
Chemical fertilizer	355	337	81%	0

Table 7.5 presents a similar story for the Bandung/West Bandung study site. The use of SWC practices is low for each practice type. Table 7.6 shows the SWC practices by plot based on their slope. More than two thirds of the plots (832) had no conservation practice used in the previous 12 month period before the survey. Farmers with vegetable plots on sloping lands do not use terraces because it reduces the available land area and too often results in water damage. More than 90% of those who do have terraces learned how build them from neighbours or they improvised on their own.

Assessing SWC adoption on farm performance: the pooled data.

To examine how SWC adoption and use impacted farm profits, we pooled the data from the Pagar Alam and Bandung/West Bandung study sites to examine multiple plot-level data for all 850 households and their 2197 plots. Our aim here is to understand the factors that facilitate or impede the probability and extent of adoption of soil and water conservation practices.

Table 7.5 SWC Practices on Plots and by Households

SWC Practice	Count Plots (n = 1286)	Percentage	Count HH (n=499)	Percentage
Terrace	191	15%	114	23%
Raised Beds	190	15%	116	23%
Ditch	66	5%	42	8%
Drainage	148	12%	90	18%
Mulch	44	3%	28	6%
Strip Grass	10	1%	8	2%

Table 7.6 SWC Practice on Plots by Slope in Bandung West/Bandung

	<15°		15° to 30°		>30°		Total Plots
	Yes	No	Yes	No	Yes	No	
Terraces	41	345	113	586	42	159	1286
Raised Beds	44	342	117	582	34	167	1286
Ditches	9	377	40	659	19	183	1286
Drainages	37	349	92	607	23	179	1286
Mulch	9	377	31	668	5	196	1286
Grass Strips	3	383	4	695	3	198	1286

We specifically examine the relative influence of policy relevant variables that shape farmers' adoption decisions: their sources of information (social and agricultural networks; government extension; farmer-to-farmer extension); the nature and quality of their information; and the farmers' climate risk perceptions.

We also evaluate the ex-post impact of four types of management implemented at the plot level (i.e., the extent of adoption) and adoption of each of the four types of conservation practices on net crop revenue. The analysis considered the four 'groups' of practices: (i) animal manure use; (ii) terraces and raised beds; (iii) mulch/compost/grass/trees; and iv) drainage/ditches/water storage (for dry land irrigation).

The study employed quantitative econometric methods to provide robust empirical evidence of the drivers and impacts of adoption on farm performance. The multivariate probit model accounts for the correlation among various conservation practices. The endogenous switching regression and instrumental variable estimators account for selectivity bias due to observed and unobserved factors.

Our results show a relatively widespread adoption of manure, but the uptake of the remaining three groups of plot management practices is limited. We do find strong complementarities between different crop practices, implying that policies and projects that promote a specific practice have spill-over effects on the uptake of other practices. For example, information related to conservation benefits and climate is more important to promote the adoption of drainage, ditch or water storage compared to price related information that helps mainly in the adoption of mulch or compost.

The empirical results show that knowledge transferred through the membership through social networks like agricultural groups and government extension services is not sufficient to scale up the adoption of conservation practices, possibly due to risk and uncertainty in implementing various conservation practices. Our findings imply that encouraging farmer-to-farmer extension and making high quality information accessible to farmers, particularly regarding conservation benefits reduces the uncertainty.

A potential policy intervention is to help farmers overcome information barriers that are vital in enhancing the adoption of SWC. For example, articulation of latest knowledge on climate and SWC may motivate farmers to adopt conservation measures. Farmer-to-farmer extension is of particular importance as it can bring about cost-effective knowledge transmission in comparison to significant public expenditure undertaking of government extension systems in Indonesia.

Overall, there is strong evidence suggesting that adoption leads to an increase in net crop revenue at the plot level. More specifically, each additional conservation practice increases net crop revenue by about 6% in both Bandung/West Bandung and Pagar Alam sites.

The positive impact of most of the practices on farm performance serves as an important economic incentive to scale up the rate of adoption (Table 7.7). Farmers are more likely to adopt different practices gradually starting with those that provide the best returns to the local conditions. Landholders will adopt new technologies only if at least two conditions are met: they see a benefit relative to their current practices; and there are no obstacles to adoption.

Table 7.7: Descriptive statistics of plot and household variables

Variables	Variable Description	Mean	SD+
Manure	Manure is practiced on the plot = 1, 0 otherwise	0.53	0.50
Terracing/Beds	Terracing and/or beds are practiced in the plot = 1, 0 otherwise	0.21	0.41
Mulch/Grass/Compost/Tree	Mulch, Grass, Compost, and/or Trees are practiced in the plot = 1, 0 otherwise	0.27	0.44
Drainage/Ditch/Reservoir	Drainage, ditch, and/or reservoirs are practiced in the plot = 1, 0 otherwise	0.31	0.46
Extent of adoption	Number of conservation practices implemented per plot (ranges 0 to 4)	1.33	1.04
Net crop revenue	Net crop revenue in Million I Rupiah	0.12	0.41

Assessing SWC adoption on farm performance in Pagar Alam.

A second econometric study assesses two types of crop management practices on farm income. An endogenous switching regression model identifies income differentials between adopters and non-adopters of agroforestry systems and adopters and non-adopters of on-far water storage for irrigation. Since farmers self-select themselves into two different groups of adoption, sample selection bias may arise due to their unobserved heterogeneity. The endogenous switching model corrects for this bias and addresses the endogeneity of the adoption in the outcome function.

The analysis demonstrates that both agroforestry and on-farm water storage adoption are associated with higher plot income, such effects being highly significant. The study shows that social group membership and education of household heads are positively associated with adoption and income in multiple adoption scenarios. The former relationship echoes literature findings suggesting the importance of peer effects and credit support.

While farmers' formal education is not directly changeable, interventions such as field schools are usually found as an effective pathway to boost farm income. Land tenure ownership is positively associated with adoption and plot income, suggesting the importance in securing farmers' land rights and secure longer term leases to protected forests.

The estimation results regarding agroforestry adoption and income effects shows that most sociodemographic measures are statistically insignificant, with only social group membership and immigration status playing positive roles. These findings are intuitive as, on the one hand, social groups can stimulate adoption because they facilitate both social learning and credit support. On the other hand, immigrants bring in innovative technologies and practices to areas where they relocate, which in turn drives rural development.

The study finds that perceived productivity loss due to climate change is negatively associated with agroforestry adoption, which is counterintuitive as one may expect that concerned farmers would be more likely to adopt an agroforestry system given its conservation benefits. Perhaps, many lower income and migrant farmers need to clear forests to support their families. Without sustainable land cover like agroforestry, further forest clearing is needed to make up productivity loss.

7.2 Key results for research Objectives 2 and 3.

In this section, we present and discuss results for Objectives 2 and 3 activities together for several reasons. First, both objectives use the land use planning models developed by the project. Objective two assesses the outcomes of alternative policy scenarios and program interventions. Objective 3 assesses the trade-offs estimated by the models between, for instance, the trade-off between farm income and environmental outcomes.

Second, both Objectives are linked to identifying relevant and practical policy and program alternatives. Third, both objectives are about engagement with, and training for, the sub-national policy community, village leaders and farmer groups. The project aspires to ensure the local policy community's goals for landscape outcomes are addressed, and to facilitate and promote access to the models for future planning purposes.

The results and discussion are organised around the two key activities: (i) the process of identifying policies and programs relevant to the local stakeholders; and (ii) an overview of how the decision support models function.

7.2.1 Identifying relevant alternative policies and programs for testing.

Since its early stages, the project teams engaged with local stakeholders through field visits, workshops and using online policy dialogues during the COVID lockdowns. These dialogues and meetings involved local development planning agencies, local agriculture offices, the state-owned forestry company, Forestry Management Units, watershed management agencies, heads of villages, agroforestry practitioners, university and government researchers and farmer groups.

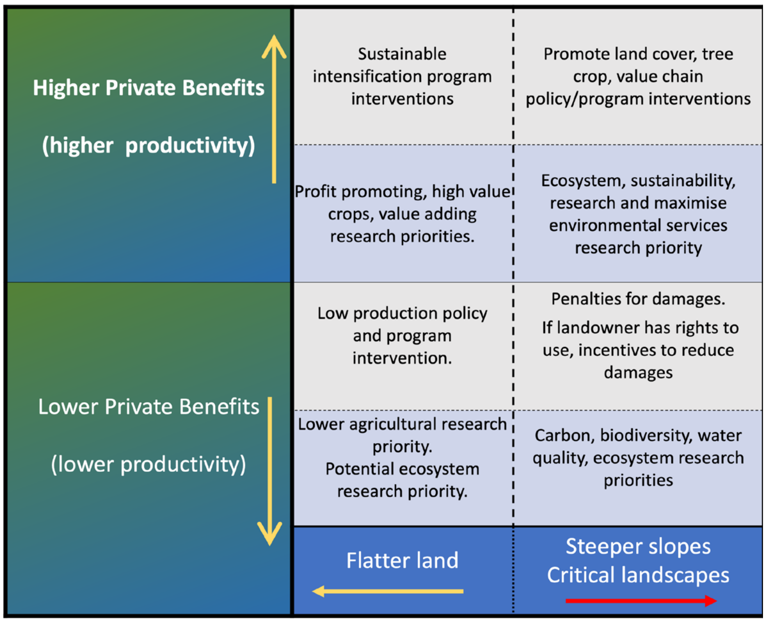
The purposes of the dialogues were to communicate the aims of IndoGreen, disseminate and validate the research results, obtain guidance on their views of the priority policy and program interventions for modelling and to present the results.

The project team collected inventories of provincial and district level government policy goals and sought input on relevant and practical programs and policies to achieve their goals.

The policy dialogues encouraged us to select potential pathways to maximise the opportunities to both increase environmental outcomes and net community welfare. Figure 7.7 illustrates one framework the project used for selecting research needs and policy/programs for different types of landscapes withing the upland catchment.

We first focus on identifying the policy goals and desired outcomes presented by the local communities, second, we identify the modelling inputs and outputs needed to generate scenarios from the decision support tools, and third we seek to understand and describe policy program pathways as a basis for informed discussion around their feasibility and approaches to testing or implementing those policies to achieve greatest benefit and efficiency.

Figure 7.7 Setting Research and Policy Priorities



The example of identifying research and policy/program priorities is presented in Figure 7.7. The landscape's productive potential is matched with its slope (soil erosion risk) and other vulnerabilities (flooding, sedimentation, landslide risks) and its ecosystems service benefits. The aim is to support sustainable crop intensification on the most productive lands, and research to support ecosystem research priorities on those landscapes with relatively high environmental values and agroforestry potential.

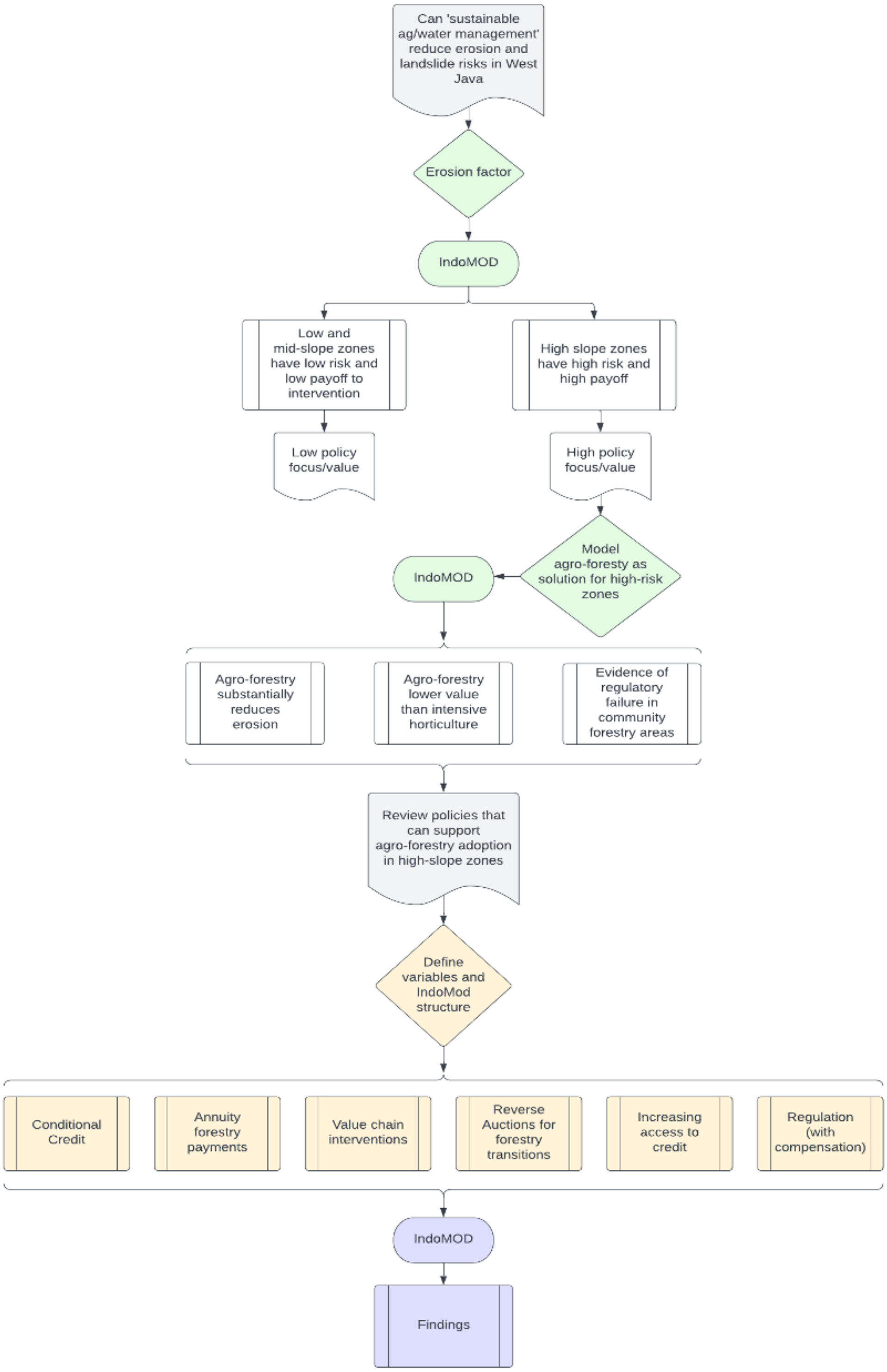
This approach recognises that landscapes vary in their potential to provide ecosystem services, often 80% of the ecosystem values come from 20% of the upland farm landscape. Likewise, most of the soil erosion and sedimentation is often concentrated in specific areas and resulting from a smaller sub-set of the farming community.

Figure 7.8 shows the pathway used to identify six policy/programs to test with IndoMap and IndoMod for the Upper Ciatrum Catchment in the Bandung/West Bandung Study site.

7.2.2 The decision support models and policy scenarios.

This section presents examples of how the project's models are used to assess the trade-offs related to policies addressing soil erosion, carbon stocks and household income. The project's decision support tools are designed to be interactive with the land use planning offices at the Provincial and district levels, as well as local communities, farmer groups village leaders. The project models are not meant to produce a 'once and for all' definitive answer. Rather the models are part of a decision-making process, providing planners and other stakeholder's a tool to help understand how different programs and policies can

Figure 7.8: Selecting example policies



produce different environmental outcomes across the landscape with different welfare impacts on farm households.

For policy analysis in the West Bandung study site, the project's IndoMod includes parameters that may be manipulated to represent changes that affect farm household decisions. One or more parameters can be changed to represent policy or other related scenarios (e.g. market price changes), with these parameters feeding into the household optimisation model and into optimal land use decisions.

While most policy analysis can be achieved by modifying policy parameters, adjustments may also be required to the model structure to represent different policy structures. For example, the IndoMod model is flexible enough to add land uses restrictions on certain land characteristics such as plot slope, tenure, and current land use.

We present here the outcomes of five alternative policy examples and the base case. The five alternative polices were informed and developed with sub-national government officials and the village and farmer groups. The modelling estimates erosion, carbon and household welfare implications from changes in parameters that are likely to be impacted from certain policy decisions.

Experiment LP_0 – Base case. The base case tests land use, erosion, carbon and household welfare outcomes estimated in the household model against observed outcomes from the map data. The parameters are set according to observed outcomes from the map information, the Bandung household survey and secondary sources. The base case model runs were used to calibrate these parameters assumptions to best resemble the observed outcomes in the landscape.

Experiment LP_1 – Adjusting coffee parameters. The first household model experiment considers the adjustment of coffee parameters to resemble a coffee value chain intervention. The aim of this intervention is to increase the returns from coffee agroforestry relative to horticulture on moderate and steep sloping land. The parameters adjusted include a price premium of 50% above the base case prices for coffee, an increase in harvest labour of 20% to account for more restrictive harvest processes, and a decrease in yield by 5% to account for the fewer cherries being accepted within a quality-controlled value chain.

Experiment LP_2 – Adjusting coffee parameters and restricting vegetables on steep land. Complementary to the changes in coffee parameters, the second experiment also seeks to restrict vegetable production on steeply sloped land. The model is adjusted slightly to not allow the optimal solution to have vegetables on steep land, meaning households reallocate their labour and capital to other land uses and plots.

Experiment LP_3 – Adjusting coffee parameters and restricting vegetables and rice on steep land. Similar to Experiment LP_2, this experiment restricts rice on steep plots. While dryland rice is rare on steep plots under the initial conditions, it is reasonable to assume that the restrictions on high value vegetables may result in households reallocating labour and capital towards rice production on these steep plots.

Experiment LP_4 – Coffee value chain interventions. Experiment 4 expands on the previous policies to test outcomes across a distribution of potential price premiums for coffee, ranging from 0% up to 200% relative to the base case. The experiment also explored the results in more detail, considered the distributional welfare outcomes for smaller and larger producers for coffee.

Experiment LP_5 – Community Forestry Annuity Scheme (CFAS). A key barrier for agroforestry production by smallholder producers is the time lag between land preparation and harvest. While input costs are low over the growth period, harvests typically do not occur for at least 10 to 20 years after the seedlings are planted. Cash flow requirements and high discount rates mean that horticulture and coffee are preferred by smallholders on steep land. CFAS seeks to provide annual payments to smallholder producer households introducing agroforestry on plots with a slope greater than 15%. These annual payments hope to increase the value and cash flow from agroforestry for risk averse households and increase the area under mixed agroforestry on steep land. The parameters adjusted in the model include revenue and prices for agroforestry products to represent a range of annual payments from year 1, rather than variable yields from fruit and timber harvests.

The IndoMod Model: alternative policy outcomes using IndoMod

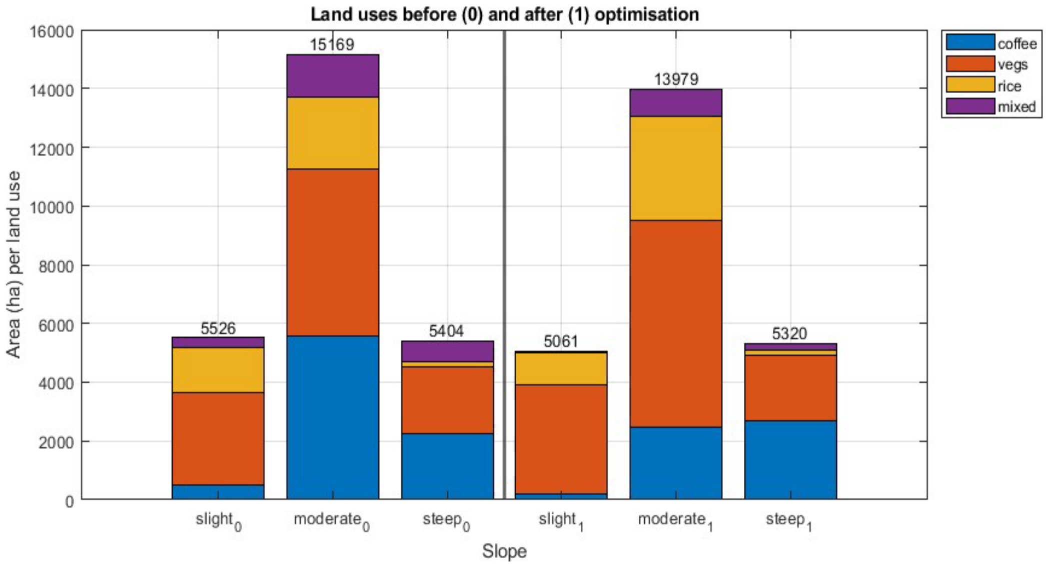
Base Case

The optimisation for the base case results in the land use patterns presented in Figure 7.9.The first result to note in Figure 7.9 is that the total area planted in plots with slight and moderate slope is lower under the optimal solution ($slight_1$, $moderate_1$) than under the initial state ($slight_0$, $moderate_0$). The total land used is 26,099 ha initially compared to 24,360 ha under the optimal solution.

Of the 1,739 ha not planted, 1,190 ha are in moderately steep land. This has implications for erosion risk given that bare land is more exposed than land under crops, plus the fact that slopes under the moderate category (15% to 30% slope) are relatively steep. The fact that some land is not used by some households under the optimal solution can be explained by several factors, such as not having enough labour or capital available to plant all their plots or finding that selling labour off farm gives a better return than using it on farm. These factors can be explored further by looking at the optimal solution in more detail.

The second result to note is that the area under vegetables increases and the area of mixed agroforestry decreases under the optimal solution in all three land slopes. The total area of vegetables increases by 1,925 ha, whereas the total areas of coffee and mixed land uses decrease by 2,997 ha and 1,333 ha respectively. These results provide a

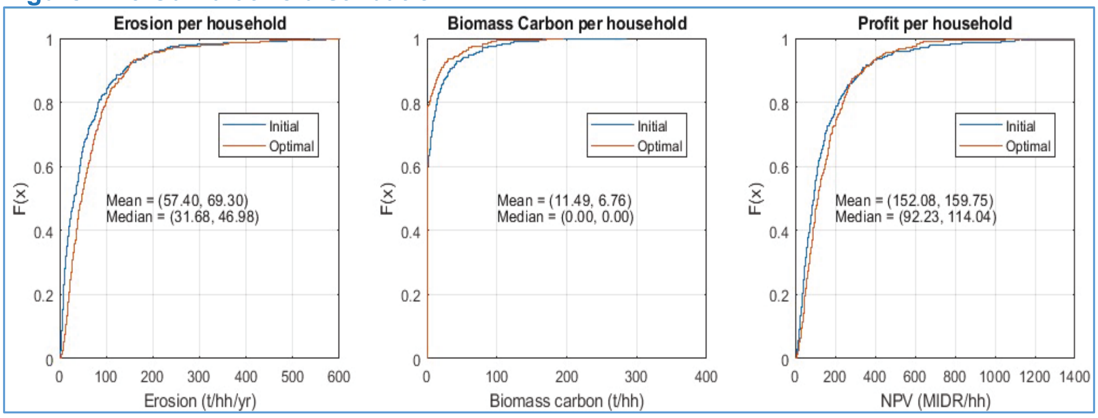
Figure 7.9 Land use results before and after optimisation with IndoMod



baseline to explore alternative policies that may reduce erosion at the lowest cost.

Figure 7.10 presents distribution of results for the three key output variables: erosion rate, biomass carbon and profit. Note that these distributions are on a per-household basis. They can also be presented on a per-pixel basis if spatial differences on the map are of interest, but here the focus on household results which are more interesting. The charts in Figure 7.10 present the variable of interest in the horizontal axis and the cumulative distribution function (CDF) in the vertical axis. CDFs represent the probability that a household selected at random will fall at or below any given value of the variable of interest.

Figure 7.10 Cumulative distribution



The first general finding in Figure 7.10 is that the means for all variables are substantially larger than the medians. This is typical of cases where there are a few people at the top end and many people at the bottom end. For example, in Figure 7.10 (C) under the optimal solution, less than 5% of farmers make > MIDR 500 (the top tail of the distribution), whereas 50% of farmers make ≤ MIDR 114 (the bottom end of the distribution).

The second general finding is that, under the optimal farm income solution erosion increases, biomass carbon decreases and profit increases in terms of both means and medians. In the case of erosion Figure 7.10 (A), the full distribution shifts to the right under the optimal solution, indicating that all households increase their erosion rate due to the shift to vegetables and some unused land as they maximise profits. Focusing on the top part of the distribution 10% of households are responsible for most of the erosion (the 90th percentile is 145 tonnes of soil per year)[1]. This result suggests that policies to reduce erosion can focus on this subset of farmers.

Focusing on the profit CDFs, Figure 7.10 (C), the result is interesting because the curves for initial profit (blue) and optimal profit (red) cross (at a profit of ~MIDR 271). At the bottom tail of the distribution the optimal solution causes a right shift in the CDF, meaning that farmers with lower incomes benefited from the optimisation. In contrast, at the top tail of the distribution the optimal CDF is to the left of the initial CDF, meaning that farmers at the higher end of the distribution experienced a slight loss in profit as a result of the optimisation. This loss may be explained by labour or capital constraints under the default parameter set and can be explored further by looking at the optimal solution (*OS*) in detail. The important point in this case is that policies may benefit some households and disadvantage others, even when the mean profit for the population as a whole increase. This means it is important to look at distributions of outcomes to understand the results fully. This is especially true when analysing equity questions.

[1] *For reference, erosion rates above 180t/ha/yr are considered heavy (Saptari et al. 2015).*

Experiments LP_0 to LP_3

In this section the results are presented for the base case optimisation model run, and experiments LP_1 to LP_3 which compare the base case model run with policies that change coffee prices (resembling a value chain intervention), while also restricting land uses on steep land.

Household and plot populations: base case and experiments LP_0 to LP_3

Figure 7.11 summarises the hectares for each modelled land use on the landscape by plot slope. Comparing the initial land uses and optimal results for the base case provides an indication of how well the model represents actual land uses on the landscape. Vegetables and rice on steep land are highlighted as these are the key land uses that may impact erosion and carbon outcomes.

The split between land uses in the optimal land use and initial land uses is approximately similar and is expected given the model parameters were calibrated to best reflect actual land use outcomes. The model suggests a lower area for mixed agroforestry than what is actually observed, and also suggests a higher proportion of area under horticulture. There are likely a range of reasons why this is the case. Households may not be maximising profits, but have a range of objectives including cash flow, labour allocations, different risk preferences, different expertise and capabilities, and sticky preferences towards current land uses (meaning farmers may be slow to change land uses when faced with new price signals). Households also have variable yields of which influence farmer decisions to change land uses that may not be captured using representative yields and inputs across the landscape.

However, it is not feasible to capture this heterogeneity in decision making a modelling exercise perfectly, so for the purposes of policy analysis the calibration exercise adequately represents the landscape.

Comparing LP_1 with the base case, the area of coffee increases on moderate and steep slopes, while the area of horticulture, rice and mixed agroforestry decreases. This is expected given the large price premium for coffee. What is interesting however is the area horticulture remains fairly persistent on these steeper slopes. These results occur due to households facing labour and capital constraints, meaning they may be unable to change land uses affordably. Those who do change land uses are able to reallocate labour and capital of which may allow for the conversion of mixed plots to annual crops and increased annual crops on moderately-slopes.

For these reasons, LP_2 and LP_3 seek to also restrict annual crop production on steep plots, in conjunction with higher coffee returns. By just restricting vegetables, households simply shift production into rice. This also occurs in the other direction if only rice is restricted. By restricting both vegetables and rice, households shift annual production into coffee production on the steeper plots.

Figure 7.11 shows the distribution of carbon and erosion of the baseline (i.e. the initial land uses) and optimal results (using base case assumptions) across the full map. The full map includes all land area in the study region, not just land operated by smallholders and can be manipulated in the household model. The yellow line represents the optimal outcome under the scenario where coffee price premiums are offered.

The optimal solutions suggest higher levels of erosion and lower carbon stocks relative to the map data. This is driven by the higher area of horticulture and lower area of mixed agroforestry in the optimal solutions relative to the map data. Carbon stocks increase slightly, and erosion decreases slightly across the map with the coffee intervention, as coffee trees displace annual crop production.

Table 7.8: Land use results.

Initial LU by slope

Slope	Coffee	Vegs	Rice	Mixed	Total
Flat	501	3,147	1,513	365	5,526
Moderate	5,568	5,672	2,480	1,449	15,169
Steep	2,267	2,247	166	724	5,404
Total	8,335	11,067	4,158	2,538	26,099

(A) Optimal (LP_0) - base case

Slope	Coffee	Vegs	Rice	Mixed	Total
Flat	230	3,745	1,155	18	5,149
Moderate	1,871	7,637	4,572	509	14,589
Steep	2,255	3,120	9	20	5,404
Total	4,356	14,503	5,736	548	25,142

(B) Optimal (LP_1) - base case + adjusting coffee parameters

Slope	Coffee	Vegs	Rice	Mixed	Total
Flat	557	3,791	918	0	5,266
Moderate	3,646	8,401	2,494	68	14,609
Steep	3,279	2,117	9	0	5,404
Total	7,481	14,309	3,420	68	25,279

(C) Optimal (LP_2) - Same as (B) + steep veg. constraint

Slope	Coffee	Vegs	Rice	Mixed	Total
Flat	230	3,745	1,155	18	5,149
Moderate	1,871	7,703	4,506	509	14,589
Steep	2,878	0	2,460	20	5,359
Total	4,979	11,449	8,121	548	25,096

(D) Optimal (LP3) - Same as (C) + steep rice constraint

Slope	Coffee	Vegs	Rice	Mixed	Total
Flat	230	3,757	1,143	18	5,149
Moderate	1,871	7,733	4,476	509	14,589
Steep	5,338	0	0	20	5,358
Total	7,438	11,490	5,620	548	25,096

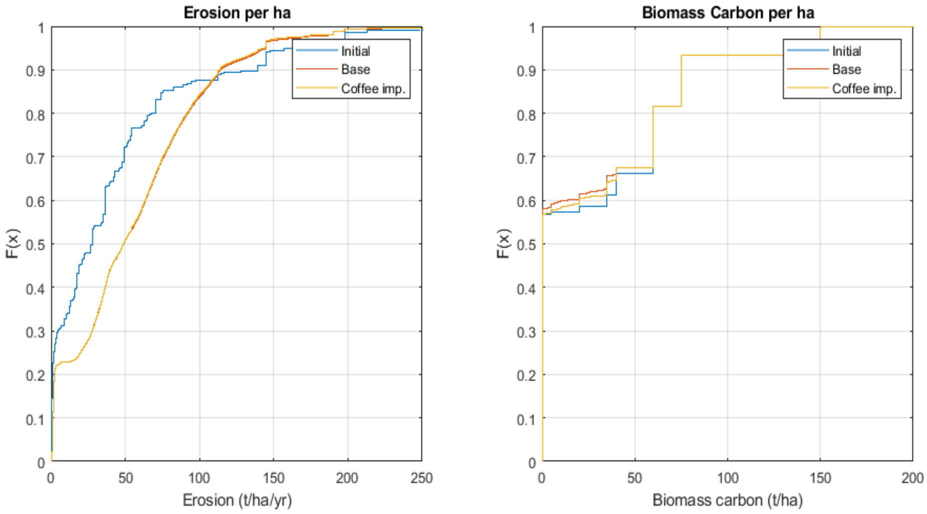


Figure 7.11: Distributions of key variables for the baseline and optimal results using the full map.

The full map hides much of the information occurring on household plots, which only represents a proportion of the total landscape.

Figure 7.12 presents the same erosion and carbon distribution for the plots that are included in the household model, between the initial conditions observed with the map data and what is estimated in the household model. This version only shows the base case optimal solution against the initial map data.

The differences are greater when looking at the households, and shows erosion is much greater and more evenly distributed in the optimal base case solution due to higher annual crop production. The same outcome is true for carbon stocks, albeit lower carbon stocks for the optimal base case solution.

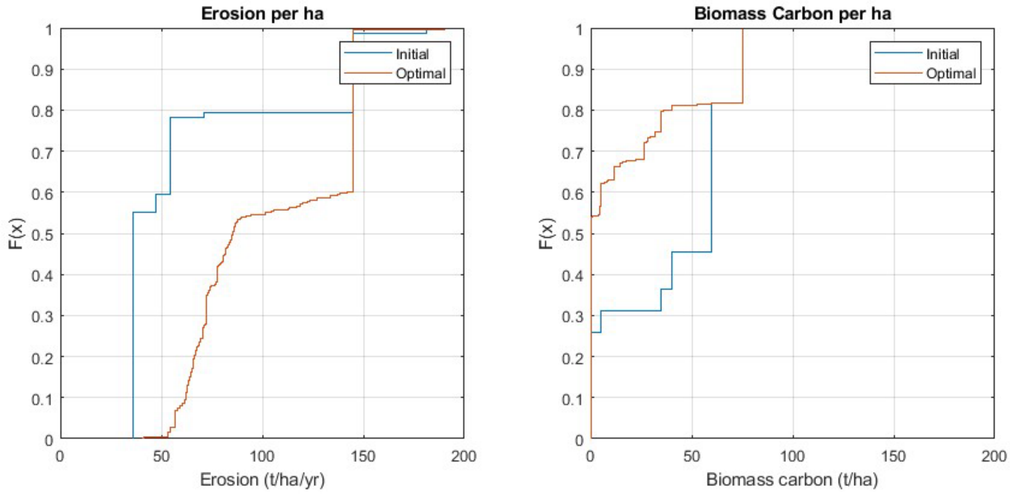


Figure 7.12: Distributions of Key variables for the baseline and optimal results using the population of household plots only.

Figure 7.13 summarises the household welfare outcomes between the observed land use outcomes from the map data and base case optimal solution, measured as a net present value of land uses over a 20-year period, discounted at 15%. This chart does not consider the net present value from off farm work which is also part of the household optimisation model.

It is expected that the households will have a higher net present value than the map data, as the model explicitly optimises household net present value from land uses (and off farm work), whereas in reality households may not be behaving optimally, have other objectives such as cash flow preferences, and have variation in yields which would influence land use decisions.

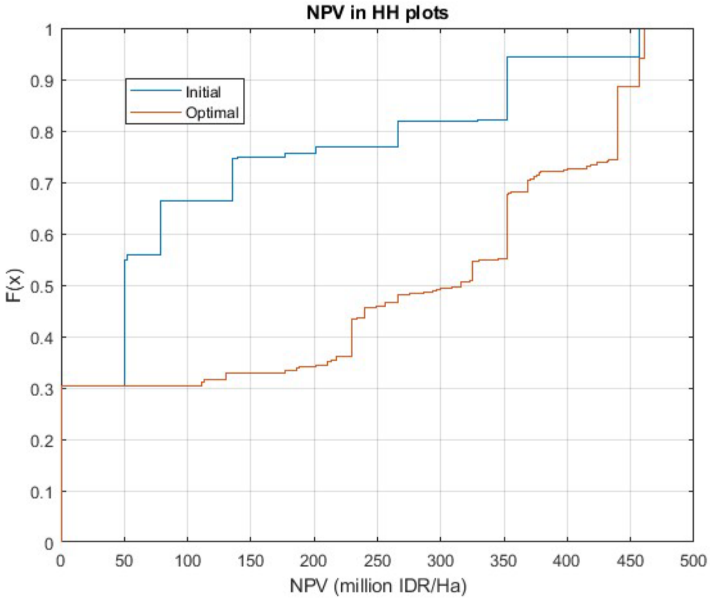


Figure 7.13: Distribution of NPV for the baseline and optimal results using the population of household plots only.

By analysing multiple policies using IndoMod, we understand the trade-offs associated with policy options seeking to achieve land use changes on the landscape. In this section we analyse trade-offs between household welfare (measured as the net present value of household income over 20 years) and soil erosion on the landscape.

The table below combines Experiments 1 to 3 to understand these trade-offs from value chain and land use restriction combinations.

Table 7.9 Policy treatments considered for policy trade-offs.

N	Treatment	Base LP	Improved coffee	Restrict steep veg	Restrict steep rice
1	Base case	X			
2	Cofimpr		X		
3	Base_SVonst	X		X	
4	Cofimp_SVconst		X	X	
5	Base_SVRconst	X		X	X
6	Cofimp_SVRconst		X	X	X

Each treatment in Table 7.9 was used as input to IndoMod and the optimisation for the farmer population was obtained in turn. The optimal solution for each treatment is contained on a separate column in a matrix of results, where each row represents a household from a population of 41,000 + farms. The main variables of interest are the optimal results for profits, erosion, and biomass carbon associated with each household, which depend on the land uses of their plots.

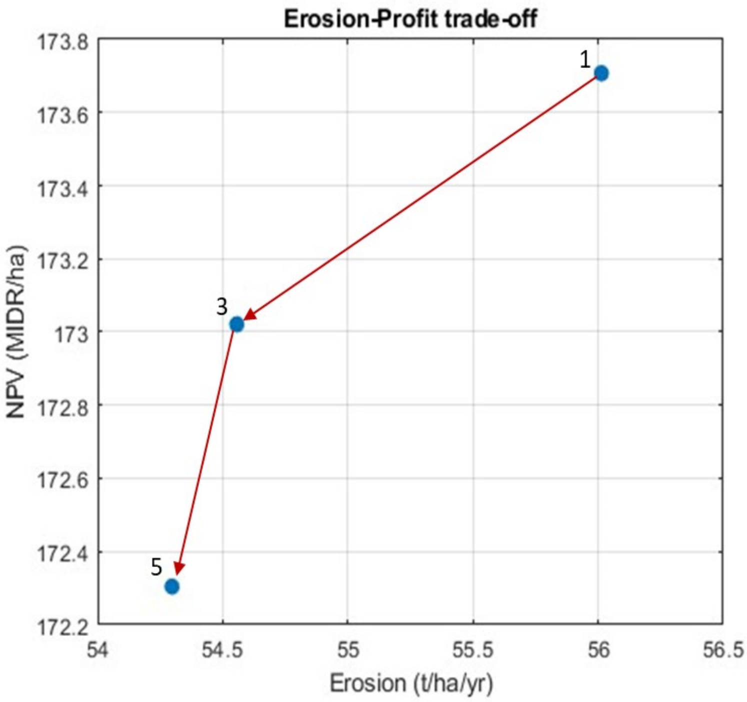
The results above show that, under the optimal solution (where farmers maximise profit, subject to resource constraints), both profit and erosion rates increase on average compared to the initial situation (Table 7.10). When land-use restrictions are imposed on steep land, both erosion and profit decrease relative to the base case. The resulting trade-off is illustrated graphically in Figure 7.14, based on average results for the full farmer population.

Table 7.10 Means of optimal results for illustrative policy evaluation.

N	Treatment	Total NPV	NPV from plots	Erosion (mean per ha)	Carbon (mean per ha)
0	Initial	152	170	43	31
1	Base case	171	174	56	30
2	Cofimpr	189	179	56	30
3	Base_SVonst	168	173	55	30
4	Cofimp_SVconst	187	178	54	31
5	Base_SVRconst	165	172	54	30
6	Cofimp_SVRconst	187	178	54	31

Starting on point 1 in Figure 7.14 the average erosion rate is 56 tonnes of soil loss per household per year, and the corresponding profit is ~IDR 173.7 million. When the first restriction on steep land is imposed, we move to point 3, with an erosion rate of 54.55 tonnes and a profit of IDR 173 million. This is an erosion reduction of 1.45 tonnes at a cost of IDR 0.7 million, so the average cost of erosion reduction with this policy is 0.48 million IDR per tonne of soil. However, further erosion reductions are more expensive. When all annual crops are banned on steep plots, we move to point 5, with an erosion rate of 54.4 tonnes and a profit of ~IDR 172.3 million per household. This is an erosion reduction of 1 tonne at a cost of ~IDR 4.7 million, almost ten times the cost of the initial reduction.

Figure 7.14 Trade-offs between erosion and profit from three experimental treatments: 1: base case, 3: no vegetables on steep land, 5: no vegetables or rice on steep land. Points represent means of each treatment for the household population.



These average results provide a useful illustration of the trade-offs involved, but we need to look at the full distribution of households to understand the cost of the policy depending on the erosion reduction target.

The cost of erosion abatement

Consider the treatments involving land-use restrictions on steep land presented in the previous section. One option for implementation of these policies is to impose the restriction and let farmers affected bear the full cost of adjusting their land uses. This will require an effective enforcement mechanism and high enough penalties to ensure farmers comply. Another option is to compensate farmers for the cost they experience as a result of the policy, with payments applying only to farmers who make the required land use changes.

In theory, a farmer would participate in such a scheme if the payment received covers or exceeds the opportunity cost of making the required change. By comparing the optimisation results of the base case against those of the restrictive policy, we can estimate the opportunity cost for each farmer affected, as well as quantify any changes in the erosion rates and biomass carbon stocks in the plots they manage. From this, we can derive marginal abatement costs (MAC) curves for erosion reduction and carbon sequestration (Figure 7.15).

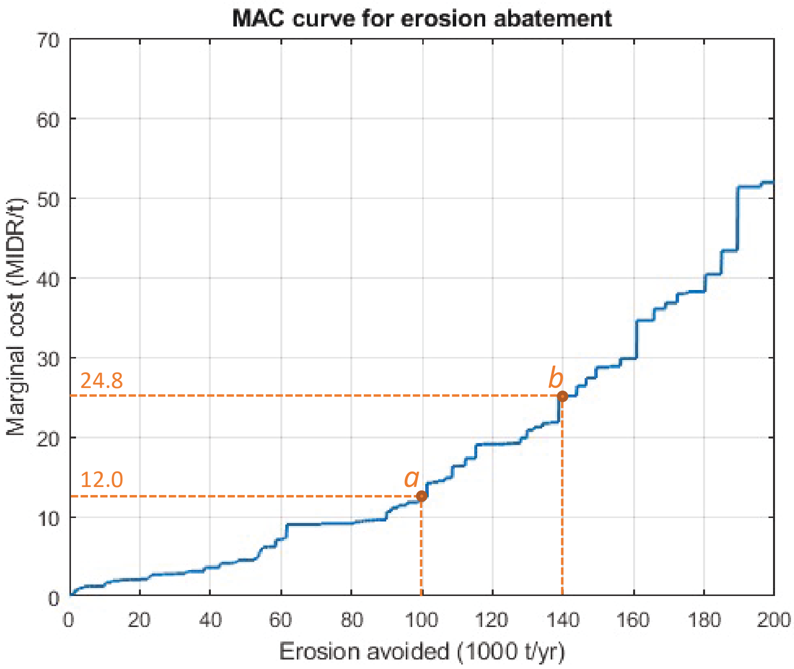


Figure 7.15: Marginal abatement cost curve for erosion reduction based on a policy that prohibits planting vegetables on steep plots.

The increasing marginal cost of erosion reduction in Figure 7.15 is typical of MAC curves for a heterogeneous farmer population. This means that larger erosion reduction targets result in higher cost per unit in an open market. As an example, point *a* in Figure 7.15 represents a reduction of 100,000 tonnes of soil loss per year, at a cost of IDR 12.0 million per tonne for the marginal farmer. If all participating farmers are paid this price, the total cost of compensation is the rectangular area formed between point *a* and the axes (100,000 × 12.0 = IDR 1,200,000 million as NPV over 20 years), the equivalent of IDR 60,000 million per year (about AUD 6.0 million per year over 20 years).

Suppose we want to increase the erosion target by moving from point *a* to point *b* in Figure 6.7. Now we have a target reduction of 140,000 tonnes of soil loss per year, at a cost of IDR 24.8 million per tonne for the marginal farmer. The total cost of this option would be 140,000 × 24.8 = IDR 3,472,000 million as NPV over 20 years), the equivalent of IDR 173,600 million per year (about AUD 17.4 million per year over 20 years. The optimal target from a social perspective is where the marginal cost in Figure 6.7 equals the marginal benefit of reducing erosion. The marginal benefit would be determined by a combination of factors including reductions in siltation of reservoirs and lower incidence of landslides. Unfortunately, data to estimate that side of the equation was not available. In reality, the target erosion reduction is likely to be determined by the budget available.

An option to reduce the cost of compensation is to pay each farmer based on their individual opportunity cost, rather than paying a fixed price per erosion reduction unit. In this case the total cost of compensation would be the area under the curve between the origin and the target point (*a* or *b*), which is much smaller than the area of the corresponding rectangle. To implement this policy would require some sort of auction which would involve some transaction costs and consideration on the contracts provided to smallholders. However, removing the rents from participation in a given policy may reduce the dynamic efficiencies of participation and could be infeasible from an equity perspective where different farmers earn different amounts from a given policy.

Results and Discussion – Coffee value chain interventions (Experiment LP_4)

As discussed previously, soil erosion on steep slopes remains a significant issue for the Citarum watershed, where high soil erosion reduces productivity for agriculture and increases landslide risks. Incentivising land use change away from annual crops and towards complex agroforestry is likely to prove more successful than establishing training programs or subsidising SWC practice adoption due to the high costs of soil conservation activities for smallholder producers.

Experiment LP_5 seeks to test the erosion and value outcomes for smallholder producers of a coffee value chain intervention, herein called the Smallholder inclusive Value Chain (SIVC).

The SIVC program operates on a 'just-in-time' contracting basis where open-market transactions are made with an efficient quality test of freshly harvested cherries that defines whether coffee cherries can be accepted. Participation in the SIVC scheme is voluntary and is derived from financial incentives/returns rather than from regulation or other policy-driven forms of coercion. Those participating do so without need for long-term contracts, and full payments for accepted cherries are made using a digital payments system on the day of acceptance. SIVC was introduced as a trial in Eastern Uganda under another ACIAR funded project in 2018, with the value chain continuing to operate successfully.

SIVC may represent a financially sustainable option achieve both erosion reductions and improved smallholder welfare as price premiums incentivise uptake of coffee production relative to higher erosion commodities such as annual horticulture and upland rice.

The key parameter tested in the model is a higher price premium for coffee relative to commodity-based coffee prices, with a range tested between 0% to 200%. Also tested in the model is a change to harvest labour where harvest labour requirements shift from less regular, large harvests with a reliance on labour share and/or hire labour to more regular harvests using family labour.

The model structure of this experiment resembles that of Experiment LP_1. However in this model run a range of price premiums are tested and compared to actual price premiums that may be achieved in a financially sustainable value chain intervention. The results are also disaggregated by household wealth to indicate whether the value chain can achieve inclusive outcomes.

Moving onto results, the introduction of SIVC successfully achieves land use change towards coffee and away from annual crops on steep slopes. For price premiums of 30-40%, the modelled average erosion per ha on steep slopes reduces by approximately 10%.

Figure 7.16 shows the empirical cumulative density function of erosion per ha on steep slopes in subdistricts with the highest average erosion. For even low-price premiums of 5%, erosion outcomes for many plots reduce. For higher premiums, land use changes tend to diminish as households with multiple plots have more labour available for reallocation from increased coffee production, allowing for the conversion of mixed plots to annual crops and increased annual crops on moderately-slopes.

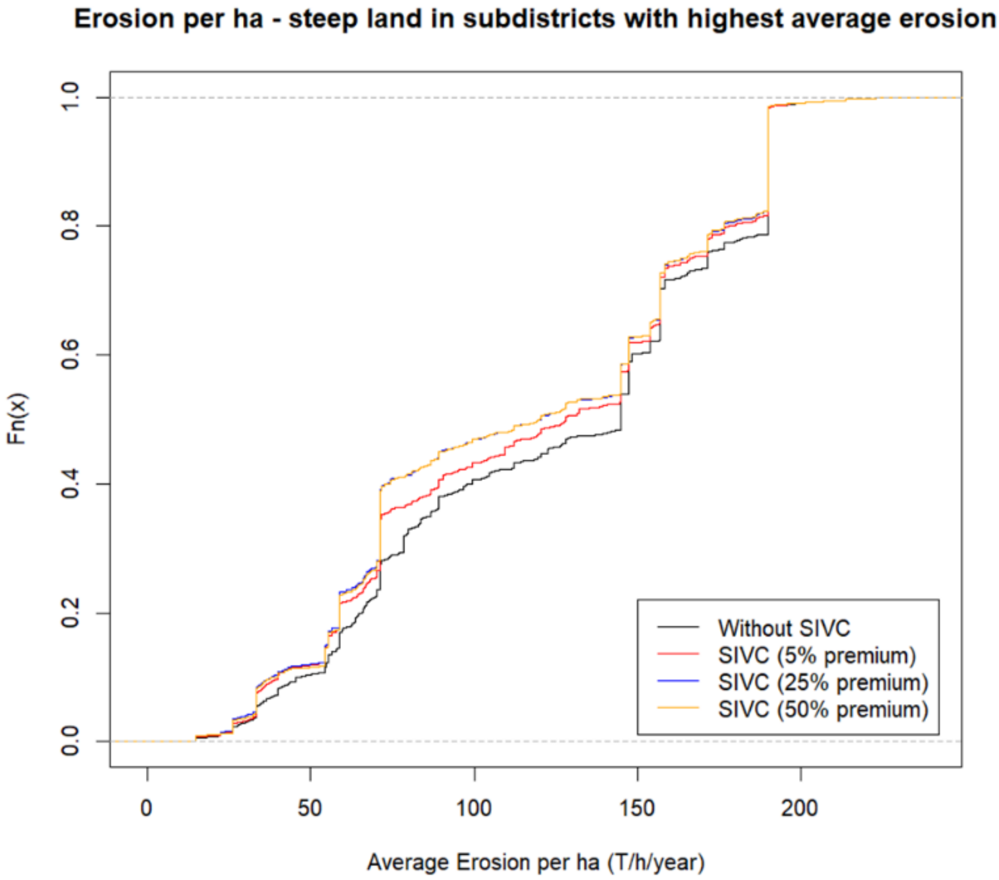


Figure 7.16: Erosion per hectare under the Smallholder Inclusive Value chain intervention – steep land in target subdistricts

For welfare outcomes for smallholders, Figure 7.17 shows the median increase in value for modelled smallholder producers for different price premiums. For a typical premium of 30-40%, the increase in household welfare over 20 years is approximately 8.3% to 8.7%.

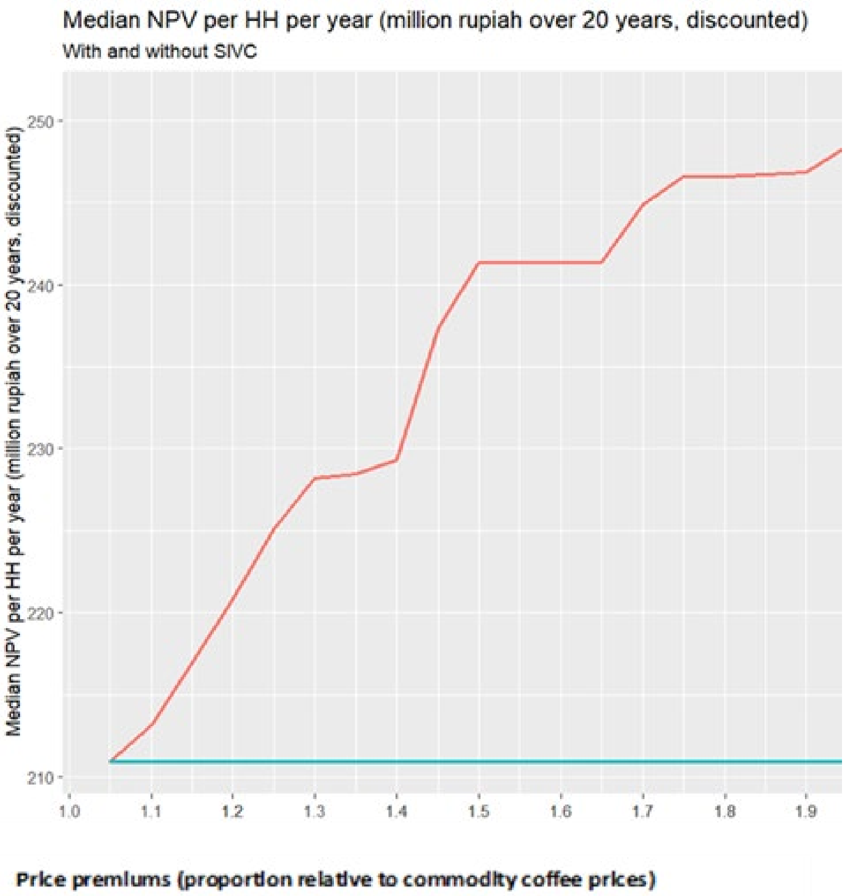


Figure 7.17: Median NPV per household under the smallholder inclusive value chain intervention

One advantage of the SIVC program is that it is available for smaller producers of coffee, where participation does not rely on expensive contracting typical to other high value coffee interventions. This also potentially has rural development implications where the program naturally targets households who will most benefit from price premiums.

However, when disaggregating the modelled value outcomes for larger and smaller producers, the value outcomes differ significantly. The median increase in value for larger producers for a 30% price premium is 6.97%, compared to smaller producers who with a median increase in NPV of 1.19%. One reason for the lower uptake from smaller producers is the prohibitive upfront costs for land use change into coffee. While not accounted for in the modelling, larger households are also able to manage low to no cash flow as the coffee plots establish, whereas smaller households rely relatively more on cash flow and home production for household consumption.

In summary, coffee value chain interventions can represent a financially sustainable option for achieving both erosion and value outcomes for smallholder households. However, complementary interventions may be required to further reduce incentives for smallholders to continue producing annual crops on steeper slopes. These interventions might include value chain interventions in other agroforestry products, upfront support for smaller producers to manage cash flow constraints as coffee crops mature.

Results and Discussion – Community Forestry Annuity Scheme (Experiment LP_5)

The Community Forestry Annuity Scheme policy experiment seeks to test the land use, erosion, and smallholder welfare outcomes for a Community Forestry Annuity Scheme (CFAS). CFAS is a policy program option that seeks to recruit steeply sloping plots in the uplands into a forestry and/or agroforestry scheme and displace intensive horticulture. It involves the creation of an independent organisation to hold plots under a long-term leasehold arrangement (20 years) and to operate a financially sustainable forestry/agroforestry program that will support payments to lessors along with achieving positive returns on investment to the government as financial backer of the program.

Currently, uptake of agroforestry by smallholders on the upland slopes is limited due to relatively low returns from mixed agroforestry relative to annual crops and limited annual cash flow from products such as timber which may only be harvested every 10-15+ years. CFAS seeks to provide annual payments to smallholder producer households introducing agroforestry on plots with a slope greater than 15%. These annual payments seek to increase the value and cash flow from agroforestry for risk averse households. The organisation makes a financial return on the annuity payments from the revenues of timber harvests.

Instead of smallholders receiving a timber harvest revenue from agroforestry under normal circumstances, the introduction of CFAS in the household model tests increasing increments of annuity payments for agroforestry and the resulting land use decisions of modelled households. These increments start from 5 million rupiah/ha/year and increase to 65 million rupiah/ha/year, which resembles the median revenue from horticultural production on flat slopes and therefore the highest value production modelled. Households are still required to prepare the land and maintain the plots annually, which includes mostly land preparation, pruning, minor weeding, and minor fertiliser and chemical applications.

Moving onto results, modelling indicates that annuity payments for forestry can increase the uptake of mixed agroforestry by smallholders in upland areas in the Citarum Watershed. For example, an annuity payment of 30 million rupiah per year per hectare increases mixed agroforestry by 1,165% on steep slopes and decreases horticulture by 60% and coffee by 37%.

This land use change has implications on erosion depending on the size of the annuity payment. The Figure 7.18 below summarises erosion outcomes for different annuity payments on steep land. As CFAS is unlikely to be eligible for plots that are leased (e.g. on State Forest Land), an alternative model run was used to restrict the policy only on plots owned by smallholders. Figure 7.19 indicates that most smallholders find it beneficial to change land uses at an annuity payment of 30 million rupiah, which reduces average erosion per ha on steep land by 22% (and 7% if restricted to plots that are not leased).

The introduction of annuity payments also has the potential to increase welfare for smallholder producers, measured in the model as the net present value of on farm and off farm income. For an annuity payment of 30 million rupiah per ha per year, welfare increases are small. But as these annuity payments increase so does welfare, with an annuity payment of 40 million rupiah providing an increase in median income for households of 13.8% (and 1.4% when restricted to plots that are not leased).

For model runs with lower annuity payments, median welfare outcomes are negative with the CFAS scheme. This is mostly an outcome of the modelling assumptions, where the model assumes alternative mixed agroforestry revenue options are no longer available. In reality, it is likely welfare outcomes will be zero as households continue to access timber harvest revenue as in the base case.

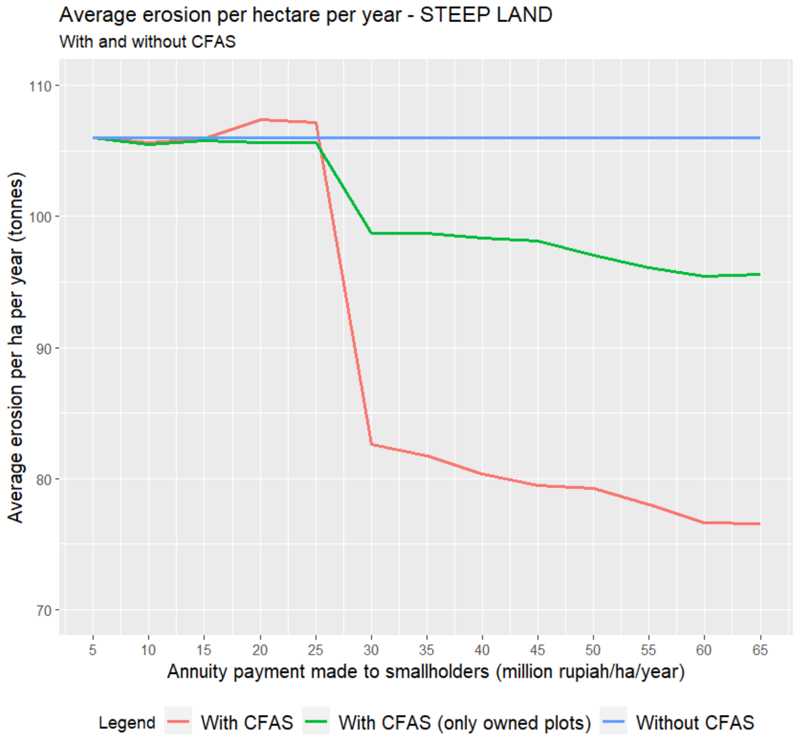


Figure 7.18: Average erosion per hectare under the Community Forestry Annuity Scheme

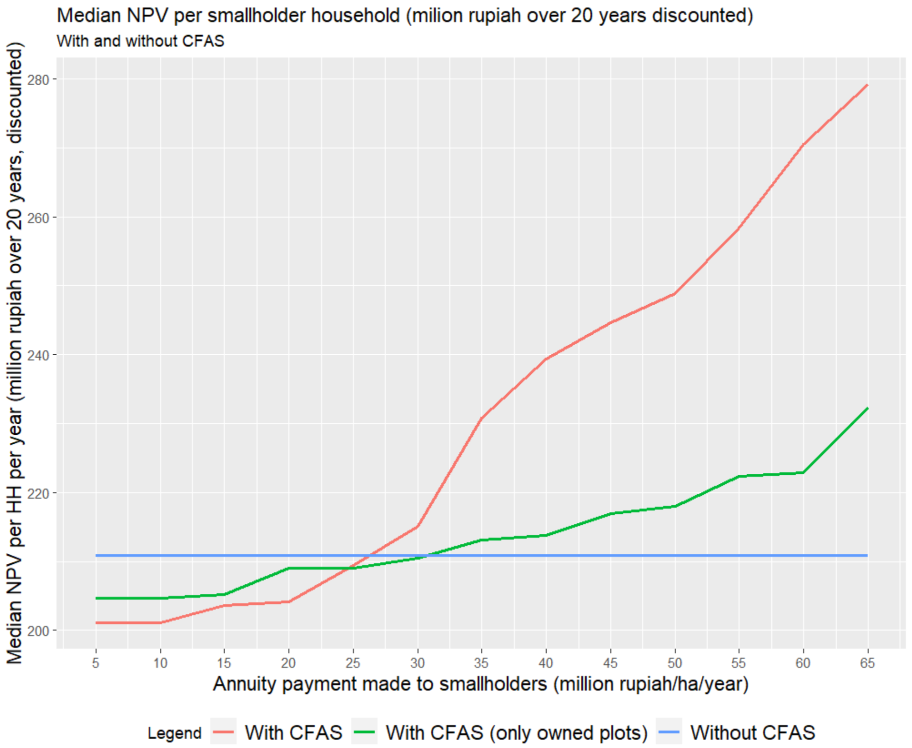


Figure 7.19: Median NPV per smallholder household under the Community Forestry Annuity Scheme

The final consideration is whether annuity payments for agroforestry (mostly timber) is financially sustainable for the organisation responsible for CFAS. The financial outcomes for different annuity payments are shown in Figure 7.20 Given the model parameters chosen, the policy has a breakeven point at an annuity payment of 25-30 million rupiah annually per hectare.

While other considerations and costs have not been included in the modelling, such as contract enforcement and pilot stages, the results suggest annuity payments for agroforestry can be both a financially sustainable and effective policy option to increase agroforestry, reduce erosion and increase farmer welfare.

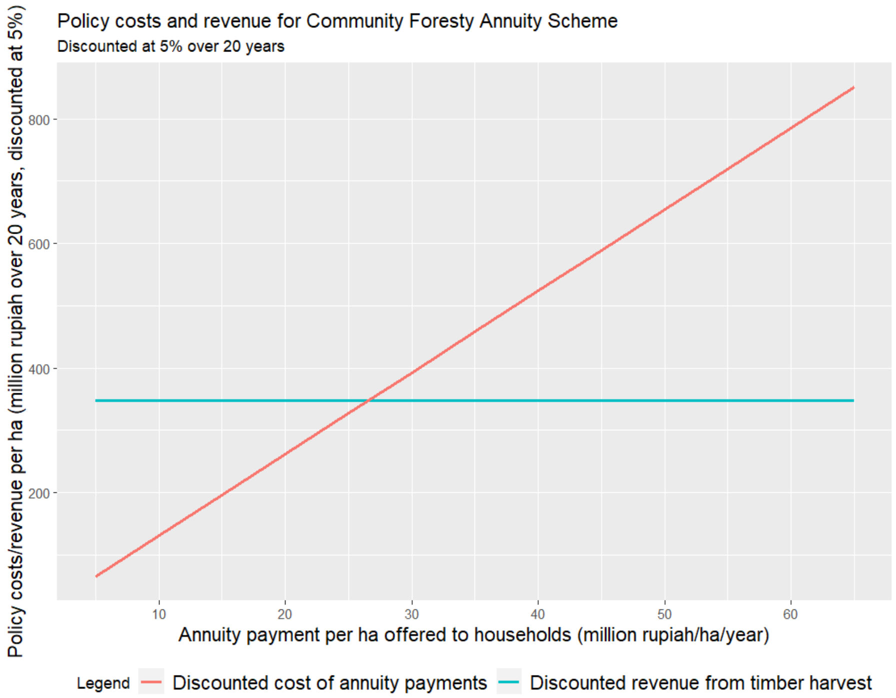


Figure 7.20: Policy costs and revenue for the Community Forestry Annuity Scheme

The KopiMod (Coffee model)

KopiMod (Kopi Model or Coffee model) is an excel-based decision-making tool developed by the project to provide a flexible, user-friendly tool to allow farmers, extension officers, village planners, value chain facilitation projects make informed decisions about the financial and land productivity outcomes from making changes to their land use farm management decisions.

This decision support tool present revenue, costs and labour requirements across different crop types to understand the trade-offs of different decisions. KopiMod has used data collected from 499 households on the slopes surrounding Bandung, West Java (ACIAR Survey ADP043 BANDUNG 2019).

KopiMod considers the discounted cash flows from four alternative land uses: coffee, horticulture, rice and mixed agroforestry – and across flat, moderate and steep slopes. Households choose the best combination of land uses across their plots given their available labour and capital.

Farmers can compare which crops provide the highest income and support the environment at the upland catchment. The model includes data for the on-farm soil productivity loss and the required replacement costs to purchase fertilizer to maintain yields.

The model uses local level data, gathered from the Bandung/West Bandung household survey, for inputs and outputs of different land uses on different slopes. The labour inputs represent all family and hired labour for each activity. Fertiliser and chemical costs are also aggregates of all fertiliser and chemical products included in the Bandung/West Bandung Household Survey.

The model has been introduced and tested with the National Research and Innovation Agency (BRIN) staff, Indonesian Coffee and Cocoa Research Institute (ICCRI) and related village heads and farmer groups. Feedback demonstrates that the KopiMod is a useful tool to provide knowledge regarding alternative crop options that can be cultivated by small farmers. Academic staff, researchers, and students are ready to facilitate the expansion of KopiMod in other regions in Indonesia by using the community empowerment programs.

The GenRiver Model

GenRiver is a hydrological model that simulates the impact of land cover changes on hydrological conditions. The hydrological conditions refer to the water balance as seen from the amount of evapotranspiration, surface flow, subsurface flow, and base flow. In addition to the magnitude, another factor to be assessed is the trend of changes in the water balance components over a certain period.

IndoGreen modified GenRiver 2.0 by adding an erosion and sedimentation simulation module. In addition to simulating the water balance, this module aims to provide an overview of the amount of soil lost due to changes in land cover and surface runoff, as well as sedimentation rates at specific outlet points.

The modified GenRiver model estimated erosion and sedimentation to provide an overview of the conditions in the upstream Citarum watershed that occurred from 2012 to 2018. The GenRiver 3.0 model was also used to test several land cover change scenarios and land conservation practices that might help reduce erosion and sedimentation rates in the future. Scenarios of land cover change and conservation were obtained based on various possible directions of land cover, as well as surveys/interviews with farmers regarding soil conservation practices that have been carried out.

The FALLOW Model

The FALLOW model is a spatially explicit landscape dynamics model that analyses drivers and consequences of land use change from the alternative policy packages on a yearly basis at the meso-scale. FALLOW is used for the Pagar Alam study site. The model has four core modules (i) plots with annual changes including crop yield, biomass growth, and soil fertility; (ii) household information on staple food thresholds, food sufficiency and economic resources for farm families; (iii) farmers' knowledge of productivity and expected yields; and (iv) spatial prioritisation on the basis that farmers are rational and select the most suitable plots for clearing and planting based on their perception of plot attractiveness.

7.2.3 Participatory Research Activity

The initial project document includes a participatory research component linking coffee farmers with high-value niche markets. This policy alternative, a market facilitation approach, is proposed by IAARD/ICASEPS to test farmer incentives to meet higher value coffee production. The aim is to assess farmers' capacity and willingness to change land cover and coffee management practices in response to receiving premium prices.

Upper Citarum Watershed

Covid forced changes to our plans, however, the project team carried out coffee value chain intervention in both the Bandung/West Bandung and Pagar Alam study sites. In the Upper Citarum Watershed, the ICSEPS team organised and supervised: (i) coffee cherry bean harvesting, explaining how and why to pick only red cherries for higher quality and profits per tree; (ii) post-harvest: knowledge and skills for washing, peeling, drying, (iii) roasting alternatives, (iv) cupping and home brewing, and (v) introduction of honeybee cultivation and processing.

The coffee interventions aim to improve the understanding and skills of coffee farmers in the study sites to produce quality coffee beans for high value coffee markets. The training theme was Coffee and Honeybees in Synergy, farmers become prosperous, natural resources and the environment are sustainable: Coffee Quality Improvement and Honeybee Cultivation Training".

The training was successfully implemented on 21-27 March 2022. The activities were held in two villages/districts, Lebak Muncang Village, Ciwidey District, Bandung Regency (22-24 March 2022), and Mukapayung Village, Cililin District, West Bandung Regency (25-27 March 2022). The Farmer Development Consultant team from the Center for Environmental Studies, Sanata Darma University, Yogjakarta, carried out the training. The consultant team consists of 8 team members.

In addition to the ICASEPS team, representatives of the Ciwidey Sub-district, the Head of Lebak Muncang Village, the District Head Forest SOE Perhutani, and the Agricultural Extension officials. In Mukapayung Village, the activity was attended by the Head of the Cililin District, the Head of Mukapayung Village, the District Head Forest SOE Perhutani, and Agricultural Extension officials.

The participants in each village were grouped into 5 groups, and each group was given a set of beehives and a bee colony. The training activities in each village ended with the presentation of each group's vision and work plans regarding coffee and honeybee cultivation. The work plans of each group are being monitored and evaluated by the ICASEPS team and the Training Team during the monitoring and evaluation activities at the end of May 2022 and mid-July 2022.

The coffee activity directly supports the provincial government in West Java's to make coffee an icon of West Java and at the same time support the national program of "Citarum Harum" to rehabilitate and improve the conditions of the upper Citarum watershed.

Pagar Alam

To improve coffee quality, ICRAF and its collaborators used training activities to help empower the coffee smallholders, including through a pilot project to introduce good management practices in collaboration with Ned Coffee (currently named Sucden Coffee), a global coffee trader. A multi-stakeholder workshop on sustainable coffee market was organised by ICRAF and Ned Coffee in collaboration with the Starbucks Farmers Centre in June 2019.

The workshop focused on: (i) coffee post-harvest processing skills; (ii) fine Robusta market strengthening; (iii) pilot project on Arabica upland coffee; (iv) coffee grafting program for Robusta trees with Arabica and Liberica variety; (v) Arabica seedling provisioning; (vi) Arabica coffee program in the Community Forestry program; (vii) Arabica coffee management training; 8) Entrepreneurship, and 9) Farmers group institutional strengthening.

Participants at the workshop included representatives from Pagar Alam Local Government, coffee smallholders from the forest frontier area, and local coffee cooperatives. Furthermore, ICRAF supported the coffee cooperatives to strengthen its value chain by directly shipping coffee to a global coffee trader in an adjacent province.

ICRAF supports the farmers in 3 upland municipalities in Pagar Alam (Central, North, and South Dempo) to access the coffee market of Louis Dreyfus Company. Beginning in December 2019, the project facilitated the local cooperative to access the funding from BRI (a government-supported bank). This fund is utilised as the seed fund for the coffee trading.

During the COVID lockdowns, ICRAF continued virtual activities to facilitate coffee farmers to strengthen their market networks with private sectors and in Pagar Alam on ways to access financial support to public financing schemes. Starting with a joint workshop between local coffee champions and a global coffee trader (Starbucks), opportunities to explore sustainable coffee markets were widely opened.

During the 2021-2022 farmers received training in evaluating coffee beans following market standards, facilitating market linkages for local cooperatives to access higher value markets and access funding for coffee improvement programs. The ICRAF team also explored the potential for digitizing cooperative management. Facilitated by a coffee activist from the Indonesian Agribusiness and Agroindustry Society, the farmer group was slowly moving towards the premium market for Pagar Alam coffee.

8 Impacts

8.1 Scientific impacts – now and in 5 years

The project's key scientific impacts include a unique household data set and four land use planning models.

This is the first household data set in Indonesia and land use model that include all the lands that farm households control. All past surveys and models focused only on the private lands operated by farmers. IndoGreen includes farmland owned, rented from individuals, leased from state forestry companies and the illegally cleared land managed by households.

The omission of non-privately owned land controlled by small households ignores fundamental incentives and influences that shape how households make decisions about what to plant, how to manage their crops, and what types of conservation practices to adopt or dis-adopt on each of their plots. This is especially important when the vast majority of farm households control much more non-owned land than private lands.

Original household survey data sets, like IndoGreen, can have significant scientific impacts by providing researchers with a valuable resource for generating new research questions, testing theories, exploring causal relationships, addressing policy issues, promoting cross disciplinary collaboration, and enabling replication and meta-analysis.

The IndoGreen data set presents a foundation for evidence based research and policy formulation, contributing to the advancement of scientific knowledge and the understanding of complex social, economic and environmental relationships.

A series of discussions and interviews with postgraduate students and lecturers at the Faculty of Economics and Management, IPB University, the University of Indonesia's Rural Gender Studies Centre and researchers from the National Research and Innovation Agency (BRIN) were conducted to assess the scientific value of the survey data.

The assessment outcomes conclude that IndoGreen's household survey data and modelling tools is already having, and can potentially have much more scientific impact by providing key insights into various aspects of the social, economic and behavioural phenomena in the selected study sites. One peer reviewed journal article published in 2022 has already had high reserach impact with five citations.

To improve the chance of future scientific imact, the project team has shared the data with academics at the University of Indonesia and Bogor Agricultural University with the purpose of understanding its ongoing and future scientific contributions.

The potential ways the survey data set can further contribute to scientific knowledge include:

i. Generating new research questions: An original data set can spark new research questions and hypotheses that were previously unexplored. Researchers can delve into the survey data to identify patterns relationships and trends that may challenge existing theories or provide novel insights into specific research areas.

ii. Testing existing theories and models: Researchers can utilize the data set to test existing theories models and hypotheses in social sciences. The survey data allows for empirical analysis statistical modelling and hypothesis testing enabling researchers to validate or refute established concepts and frameworks.

iii. Exploring Causal Relationships: With a rich household survey data set researchers can employ advanced statistical methods to investigate causal relationships between variables. By carefully designing the survey and collecting relevant information it becomes possible to study the effects of certain interventions policies or socioeconomic factors on household outcomes thereby enhancing our understanding of cause-and-effect dynamics.

iv. Addressing Policy and Development Issues: Household surveys often capture data on various socioeconomic dimensions including income education health employment and living conditions. These data can be instrumental in informing policy decisions assessing the impact of social programs and identifying areas for intervention or improvement in areas such as poverty alleviation education healthcare and social welfare.

v. Enhancing Cross-Disciplinary Collaboration: Original household survey data sets have the potential to facilitate collaboration between researchers from different disciplines. These data sets can be utilized by economists, sociologists, ecology, land use planners, demographers and other social scientists fostering interdisciplinary research that provides a comprehensive understanding of the complex societal issues in Indonesia's upland landscapes.

vi. Replication and Meta-Analysis: Open access to the IndoGreen household survey data set enables other researchers to replicate studies verify findings and to conduct meta-analyses. This transparency and reproducibility strengthen the credibility and scientific rigor of the research allowing for broader impact and the accumulation of knowledge over time.

8.2 Capacity impacts – now and in 5 years

Capacity building impacts among research partners.

The project improved the knowledge and skills of the implementing partners through workshops and research collaborations. Project partners share and improve their understanding on various research methodologies, such as ecological and socio-economic survey methods and modelling, approaches (i.e., survey tools and "how-to" make use of participatory approaches) and activities applied in each site.

Internal training enabled knowledge exchanges and targeted government researchers. The training equipped researchers with tools for developing policy recommendations in integrated watershed management through applying the Generic River modelling framework.

During the household surveys in Pagar Alam and West Bandung, the national field facilitators were equipped with online tablets coupled by paper-based questionnaires. For ICRAF researchers, the Pagar Alam survey was their first exposure using online tablets, The ICRAF research team and enumerators concluded that the online tablets improved the efficiency, speed and accuracy of the data collection, entry and cleaning.

Targeting wider audiences, in collaboration with Padjajaran University, Wageningen University, and ANU; ICRAF and the University of Adelaide organised a training workshop on ecosystem services, valuation and financing mechanisms for production landscapes attended by 24 participants. The aim was to enhance the capacity of national government research centres, private sectors, NGOs, and local universities participants in managing the landscape and developing policies for natural resource management.

Capacity building activities for farmers

The IndoGreen project delivered training for farmers focusing on coffee harvesting and processing techniques, and honeybee cultivation techniques at the upland catchment areas. The training was conducted twice at different locations: (i) Mukapayung Village, Subdistrict Cililin, West Bandung. The training was attended by 26 participants and six out of 26 participants were women; and (ii) Lebak Muncang Village, Subdistrict Ciwidey, Bandung District. The training was attended by 25 participants and four out of 25 participants were women.

ICRAF supported the farmers in 3 upland municipalities in Pagar Alam (Central, North, and South Dempo) to access the coffee market of Louis Dreyfus Company (LDC). In September 2019, these farmers sent their samples of fine and low-quality Robusta Coffee to the coffee trader office. In December 2019, the project facilitated the local cooperative to access the funding from BRI (a government-supported bank). This fund was utilised as the seed fund for the coffee trading. The cooperatives started to supply LDC in the next harvesting season August 2020, and up to December 2020 it has sold 100 tonnes of coffee beans. The cooperative continues to supply LDC up to now.

An assessment of the farmer training activities included discussions with the study team, academic staff from IPB, and researchers from BRIN related to the training activity and evaluations by the farmer participants. The evaluation outcomes include:

Effectiveness: The training provided support for farmers to implement sustainable farming practices in the upland catchments by raising awareness of the economic, environmental, and social elements in sustainable agriculture. To spread impacts, similar training should be conducted in other producer areas of coffee in Indonesia through community empowerment programs. Students, researchers, and extension staff can facilitate local governments to conduct such training in other regions.

Relevance: The training matched farmer requirements for learning ways to increase productivity while still prioritizing environmental aspects and improve coffee income. The trend for requirements for environmentally sustainable coffee is increasingly in demand for accessing the international market. Currently, agricultural products including coffee are no longer only assessed based on the quality of their products but also on how the basis of the coffee production on sustainable cultivation circumstances run. Through the training, farmers are provided the opportunity to increase their knowledge on how to run sustainable multi-products (coffee and honey) at the upland area. Beekeeping can support coffee pollination, hence increase the productivity of coffee.

Sustainability: The Coffee and Honeybee training had been designed to meet the sustainability objectives of the upland farming practices, balancing the short and long-run objective of upland farming management, balancing the short-run interest of farming (farm's revenues and profits) and the long-run interest of sustainability of natural resources.

It is expected that coffee and honeybee farming practices can meet farmers' interests of relatively high, continued, and sustainable incomes without further depleting natural resources and environments.

Gender: In the coffee and honeybees' training, female participants were included. In practice, many women are responsible for key coffee and honeybee activities as well as supporting a range of post-harvest activities that are key to quality outcomes.

Innovation*:* The introduction of coffee harvesting and processing techniques and honeybees' cultivation techniques support farmers to engage in integrated farming as well as provide solutions to overcome the challenges among economic, social, and environmental elements at upland regions. By implementing the knowledge from the training, farmers can increase their income, increase labour absorption, and provide a positive contribution to the environment.

In the Pagar Alam study site, during the 2020-2022 farmers were trained in evaluating coffee beans to align with market standards and facilitated to local cooperatives in accessing markets and agricultural funding, as well as exploring the potential for digitizing cooperative management. Facilitated by a coffee activist from the Indonesian Agribusiness and Agroindustry Society, the farmer group was slowly moving towards the premium market for Pagar Alam coffee.

To improve coffee quality, ICRAF and its collaborators empowered the coffee smallholders, including through a pilot project to introduce good management practices in collaboration with Ned Coffee (currently named Sucden Coffee), a global coffee trader. A multi-stakeholder workshop on sustainable coffee market was organised by ICRAF and Ned Coffee in collaboration with and the Starbucks Farmers Centre in June 2019.

Participants at the workshop included representatives from Pagar Alam Local Government, coffee smallholders from the forest frontier area, and local coffee cooperatives. Furthermore, ICRAF supported the coffee cooperatives to strengthen its value chain by directly shipping coffee to a global coffee trader in an adjacent province.

The project support two Indonesian PhD students at the University of Adelaide and one Australian student at the University of New England. Between them, the students have published four journal articles based on IndoGreen research.

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

Indonesia's upland agriculture accounts a significant share of agricultural exports, an important source of income, jobs and food as well as playing important roles as hydrological and biodiversity buffer zones. Potential community impacts include better targeted and improved village-level public infrastructure, including roads, wholesale markets, community training in certification programs, micro-hydro power and extension and training programs.

The project included studies of three catchments with populations of some 16,000 to 24,000 inhabitants (4,000 to 8,000 households per catchment). The scale of the potential economic benefits is related to the project's success in providing useful evidence, communicating that evidence and empowering the local policy community with practical tools and a network for making more productive investments in public infrastructure, reducing productivity loss caused by inappropriate land use practices and adopting crops practices that result in high quality, high value produce.

The project aimed to produce long term economic impacts that include: (i) higher farm household incomes, less income variability and greater food security; (ii) more jobs and/or higher real wages for landless; (iii) lower economic costs to downstream, 'off-site' communities due to lower soil sedimentation and flooding; and (iv) increased economic growth and investments in villages.

The project output examples that can potentially lead to net positive direct and indirect economic impacts for households and communities include the four land use decision models, the training and capacity building for farmers and sub-national government officials and the policy dialogue workshops with the policy community.

The project team are continuing post project activities to facilitate coffee farmers to strengthen their market networks with private sectors and access financial support to public financing schemes. In Pagar Alam, the coffee training builds on the joint workshop between local coffee champions and the global coffee trader Starbucks.

ICRAF continues to facilitate coffee farmers to strengthen their market networks with private sectors and access financial support to public financing schemes.

8.3.2 Social impacts

The social impacts to date are limited. However, the project's outputs form the basis for future impacts.

Establishing the Foundation for Social Capital Building

In partnership with provincial and district government officials, village leaders and farmer groups, cooperatives, and individual farmers, the project developed land-use planning tools that incorporated local data, local maps, local concerns. This participatory research process established a network of stakeholders that actively debate the social consequences of their policy decisions.

Potential and practical future social impacts of this network include:

i. Enhanced Stakeholder Engagement: By bringing together stakeholders from various sectors, including government, local communities, non-governmental organizations, private agribusinesses and researchers, the land use planning networks foster collaboration and engagement. The engagement allows for diverse perspectives and expertise to be shared, promoting inclusive decision-making processes and ensuring that the voices and concerns of all stakeholders are considered.

ii. Improved Land Use Decision-Making: The IndoGreen land use planning model serves as a tool for stakeholders to better understand the trade-offs between profit, productivity loss and environmental outcomes. Through the network, stakeholders gain access to reliable data, simulations, and scenario analyses, enabling them to make more informed decisions regarding land use policies, resource allocation, and sustainable development strategies. This can potentially lead to a more equitable decision-making process that considers both social and economic aspects.

iii. Stakeholder Empowerment: The land use planning network empowers stakeholders by providing them with knowledge to actively participate in land use planning processes. Through the training workshops, capacity building programs, and knowledge sharing platforms established by IndoGreen, stakeholders can enhance their understanding of economic and environmental trade-offs, build technical skills, and contribute to the development of sustainable land use strategies. This empowerment strengthens local communities and organizations, fostering a sense of ownership and responsibility for upland landscapes.

iv. Collaboration for Sustainable Development: The land use planning network encourages collaboration and new partnerships, facilitating the exchange of best practices, lessons learned, and innovative solutions. By cooperating, the new network can develop integrated strategies that balance economic growth, environmental outcomes, and social welfare. This collaboration can lead to the implementation of locally appropriate program initiatives, improved land use management practices, and the improved ecosystem services in upland landscapes.

v. Social Awareness and Education: The land use planning network provides new opportunities for education and awareness-raising initiatives focused on the economic and environmental trade-offs in upland landscapes. Through workshops, public forums, and outreach programs, stakeholders can educate local communities, policymakers, and the general public about the importance of sustainable land use practices. This increased social awareness can lead to a broader understanding of the interconnectedness between land, livelihoods, and the environment, fostering a culture of sustainability and responsible stewardship.

8.3.3 Environmental impacts

The most likely positive environmental outcomes the project can contribute in the future are: (i) better management of soil erosion, soil nutrients and land degradation; (ii) lower organic and inorganic pollution leading to water and soil contamination; and (ii) less conversion of key protected forest land and less conversion of tree crops to annual crops on steeply sloping lands.

We expected the major environmental impact of this research to come through reducing soil erosion. Empirical evidence demonstrates that as soil erosion and land degradation increase, on farm agricultural productivity decreases, leading to a downward spiral of reduced incomes and increased degradation accompanied by lower productivity and higher production costs from fertilser use. The farmers recognise the soil erosion associated with converting land from tree crops to vegetables. The land use planning tools provided them with a better understanding of the longer term consequences as the data used in the model came from their farms.

In addition, the land used model's maps made it clear to the local government and farmer groups that erosion impacts are concentrated amongst a few households in specific areas of their catchment. This suggests that policies can target certain households and regions where the marginal cost of erosion abatement is lowest – likely where households and regions have the highest average erosion. Policy may also consider the subset of the landscape where risks of erosion are greatest in respect to landslides or where sediments are most likely to enter sensitive water ecosystems.

8.4 Communication and dissemination activities

The project team participated in numerous workshops and conferences in Australia, Indonesia, New Zealand and Europe. Communication activities included workshops with local village leaders, district heads, Provincial offices and National Ministries. Output has been shared with international researchers and the international development community including UNEP, FAO, the World Bank, OECD and IFAD.

Publications include 6 journal articles, 5 books/manuscripts, 27 Project Briefs, 23 Project Working Papers, 3 land use models with 5 online video sessions explaining how to use the models, web blogs, a dozen keynote presentations at conferences with video links, 6 formal policy dialogue sessions, 12 informal policy dialogue sessions, 5 working papers in Bahasa, 4 Posters in Bahasa, 12 Infographics in Bahasa, 4 Technical Papers, 4 Background Papers, 2 PhD thesis and 5 video presentations by PhD students.

Section 10.1 provides a list of all these publications and presentations with links for online access.

Appendix 11.1 provides a list mapping how the various publications are linked to specific activities of each of the 3 project objectives.

Web blogs: ICRAF and University of Adelaide Web Blogs

Preliminary Visit and Survey process

Sustainable Coffee Workshop for Local Coffee Farmers, in collaboration with private sectors (NedCoffee and Starbucks)

An Instagram posting on the ecosystem services and valuation training

Videos and Online Presentations

Sara Qanti, IndoGreen PhD student's Three Minute Thesis Presentation: Women's participation in agricultural decision-making (https://vimeo.com/575614082)

Sara Qanti, Social Norms and perceptions on women participation in agricultural decisions: The Case of West Java AARES Conference February 2021 (https://www.dropbox.com/s/pjehvz7x2m6ttn9/1457_AARES%202021_Sara%20Qanti_final.mp4?dl=0)

ICASEPS Team, seven-minute video highlighting the training workshop April 2022: Integrating good quality coffee production with honeybee. Indogreen coffee training in Lebakmuncang Village, Bandung District and Mukapayung Village, West bandung District

Sara Qanti, Petani, perempuan, dan pengambilan keputusan (Farmers, women, and decision making), Guest speaker for Indonesian Students Association in Australia (https://www.instagram.com/tv/CcKVeflB5Kt/?hl=en)

Sara Qanti, Penggunaan pupuk, konservasi tanah dan air, dan pelibatan perempuan (Fertiliser use, water and soil conservation, and women's participation), Seminar Series Forum Kajian Pembangunan hosted by Center for Indonesian Policy Studies and National Research and Innovation Agency (https://youtu.be/R6GIYgeKy-M)

Media Monitoring includes:

https://sumatra.bisnis.com/read/20220412/534/1522210/petani-kopi-pagaralam-butuh-penguatan-akses-pasar

https://www.liputan6.com/regional/read/4939291/hasil-riset-pertanian-berkelanjutan-indogreen-jadi-acuan-kebijakan-di-pagar-alam

https://sumsel.antaranews.com/berita/634637/peneliti-icraf-sarankan-pengembangan-agroforestri-pada-perkebunan-kopi-pagaralam

https://www.merdeka.com/peristiwa/kopi-pagaralam-citra-rasa-robusta-yang-terkendala-akses-pasar.html

https://palembang.tribunnews.com/2022/04/12/dukung-pagar-alam-menuju-besemah-hijau-indogreen-serahkan-hasil-penelitian-lanskap-pertanian?page=all

https://id.berita.yahoo.com/kopi-pagaralam-citra-rasa-robusta-120154942.html

https://www.timesindonesia.co.id/read/news/405544/indogreen-serahkan-hasil-penelitian-ke-pemkot-pagaralam

9 Conclusions and recommendations

IndoGreen provided decision making tools for Indonesia's development policy community to support better welfare and environmental outcomes for smallholders in upland landscapes. To achieve this research focused on three upland catchments facing declining on-farm agricultural productivity and negative environmental outcomes for the wider catchment.

The project was motivated by the Indonesian government's concerns that land use policies and regulations contribute to soil erosion, soil nutrient loss, productivity declines, flooding, landslides, river and reservoir sedimentation and biodiversity loss. A second, equally important, issue relates to evidence suggesting that valuable agricultural extension and advisory services aimed at mitigating improper land use practices are adopted for only a few cropping seasons, before being abandoned by farm households.

In response to these concerns, the Australian Centre for International Agricultural Research (ACIAR) project ADP/2015/043 (Agricultural Policy Research to Support Natural Resource Management in Indonesia's Upland Landscapes, or IndoGreen) improved the understanding of socioeconomic and environmental impacts of existing national and local policies in three upland catchments in Indonesia, and assessed the impacts and trade-offs associated with alternative policies.

9.1 Conclusions

The key conclusions arising from the data and policy analysis in the project are:

Anthropogenic activities and societal transformations are driving land use and land cover change across Indonesia. Urbanisation, population growth, economic development, rural to city migration, increasing incomes, shifts in diet preferences and an expanding middle class are major contributors in explaining why and how land uses are altering. Overall, annual per capita consumer spending on food has averaged more than 5% a year since 2010. This rapid transformation presents farmers with new and highly profitable opportunities to participate in higher value fruit and vegetable chains and in domestic and export niche coffee markets.

Vegetable production provides the highest returns of production in the uplands, but a range of other factors influence land use decisions by households. Based on the mean results from the household survey, vegetables are the best option in terms of expected profit and return to labour. However, vegetable production on steeply sloping land greatly increase soil erosion, on-farm productivity losses, off-farm environmental damage, lower carbon storage and lower biodiversity outcomes.

There has been significant land use change between 2012-2018 on the upland slopes. In general, there has been a transition on the landscape where forest area and agroforestry have been replaced with annual crops and mixed gardens with tree and annual crops, especially in the Upper Citarum study site. This land use change has translated to 2.35 million tonnes of CO_2 emitted through land use change over a six-year period, but a decrease in erosion since 2015 due to increased mixed gardens on steep slopes and utilisation of cleared land. The land use changes show that farming systems in the study region are dynamic and responsive to changes in prices and other factors such as population growth, expected yields and household preferences for agricultural production.

No one policy is likely to result in both welfare increases and erosion reductions. In our policy simulations, the area under horticulture did not decrease significantly despite increased price premiums and returns from coffee and agroforestry. Households own multiple plots, and they choose to allocate their household labour and capital across these plots. By responding to price premiums under an intervention, they can reallocate their resources to other plots and land uses. These same households have a range of alternative objectives and preferences from their production systems, including cash flow, risk minimisation, cultural preferences for home consumption, and skills and expertise in certain production systems. These factors mean that one policy option to reduce erosion outcomes in the landscape will not be sufficient, and policy makers need to consider the interacting effects of existing and new policies on heterogeneous farmer behaviour.

Erosion impacts are concentrated amongst a few households. The distributions of erosion on the map and households suggest that the majority of erosion occurs from a smaller subset of plots and households. This suggests that policies should target certain households and regions where the marginal cost of erosion abatement is lowest – likely where households and regions have the highest average erosion. Policy may also consider the subset of the landscape where risks of erosion are greatest in respect to landslides or where sediments are most likely to enter sensitive water ecosystems.

Returns from mixed agroforestry are relatively low, and incentives suggest the area under timber will decrease without intervention. The modelling suggests that returns from mixed agroforestry returns remain low for smallholder households. High upfront costs, long time horizons to realise cash income, and risks and uncertainty over future returns limit the benefits from timber for smallholder farmers. It is unlikely that households voluntarily invest in mixed agroforestry relative to other crops such as coffee and horticulture. If further adoption of agroforestry is wanted, it is necessary to consider how policies can increase the value of agroforestry for smallholders and target households, and identify areas where the marginal cost of the policy is lowest.

Interventions should consider the distributional consequences of policy options. The distributions of revenue, costs, and labour requirements presented in Chapter 3 show significant heterogeneity in outcomes for smallholder producers who otherwise grow the same crops in the same region. Results from the policy analysis in Chapter 6 also show that for Experiment 4, larger households are able to capture the majority of benefits from the program as they can afford the upfront land use change costs and are more likely to have existing coffee plots.

The distribution of outcomes, as presented in the results, may have implications on the success of policy design. While win-win policies may exist for reducing erosion and increasing household welfare, the lowest cost erosion reduction methods may be through larger households and may not be the most effective method to increase welfare of those in poverty, and vice versa.

9.2 Recommendations

The project team offers the following recommendations.

1. Facilitate the further use of the project's unique data sets on land use changes and gender implications. All project partners and other institutions are encouraged to participate. At present, Bogor Agricultural University and the Rural Gender Studies Group at the University of Indonesia are experimenting and helping to provide broad access to the data set, code book and survey instrument. A related recommendation is that future work on gathering data for analysing drivers and outcomes of land use changes adapt the survey instrument produced by this project. The necessary data could be collected at a lower cost by adapting existing templates and using a more targeted sample design.

2. **The project team strongly recommends that other ACIAR and development projects of this type engage with the sub-national governments**. Our focus was on analysing and adapting policies and regulations to gain environmental and livelihood outcomes. We found an extremely high level of interest and sustained involvement by provincial and district governments, but much less interest form the national level policy community.

3. Assess the capacity and willingness of communities to participate in environmental programs based on improved coffee value chains. The assessment should target the three levels of farmers, villages and local government, and determine their willingness to change land uses away from annual crops to capture premium coffee prices while providing environmental services. The assessment should also identify constraints for Indonesia's coffee producers to market high-value Robusta coffee chains in upland communities.

4. **Facilitate value chain innovation by assisting women farmer groups to take advantage of existing programs**. The initial focus should be on the Korporasi Petani ('Farmer Group Enterprises') program, identified and prioritized by President Joko Widodo as a 'major project' in RPJMN 2020–2024

5. **Expand and test the IndoGreen approach of involving the local land use planning community, village leaders and extension services in the value chain process**. The aim is to encourage greater value chain innovation through wider participation and greater buy-in to identifying and solving issues at the local level. This would involve the Indonesian team maintaining contact with the target communities and maintain momentum.

6. **Promote adoption and adaptation of IndoMod to contribute to policy analysis in this and other study sites**. This would be based on the existing training materials, but would also look at ways of making the tool more user friendly and modify it to represent different decision-making approaches by farmers. A short intensive course could be organised collaboration with BRIN, inviting academics and post-graduate students to participate.

10 References

10.1 References cited in report

ABT Associates. (2013) Support Services for Land Use Planning, District Readiness, Strategic Environmental Assessment, and Related Preparatory Activities in Indonesia for the Green Prosperity Project in Indonesia, 13 January 2013.

Andersson, JA & D'Souza, S 2014, 'From adoption claims to understanding farmers and contexts: A literature review of Conservation Agriculture (CA) adoption among smallholder farmers in southern Africa', Agriculture, Ecosystems & Environment, vol. 187, no. 0, 4/1/, pp. 116-132.

Arslan, A., McCarthy, N., Lipper, L., Asfaw, S., Cattaneo, A. and Kokwe, M. 2015, 'Climate Smart Agriculture? Assessing the Adaptation Implications in Zambia'. Journal of Agricultural Economics, vol 66, pp. 753–780.

Asfaw, S., McCarthy, N., Lipper, L., Arslan, A., & Cattaneo, A. 2016, 'What determines farmers' adaptive capacity? Empirical evidence from Malawi', Food Security, vol 8, no. 3, pp. 643-664.

BAPPENAS (2015) RPJMN National Mid-term Development Plan 2015-2019, Rencana Pembangunan Jangka Menengah Nasional/RPJMN, MoA, 2015.

Busch J, R. N. Lubowskib, F. Godoya, M. Steiningera, A. Yusufc, K. Austind, J. Hewsona, D. Juhna, M. Faride, and F. Boltzf (2012). Structuring economic incentives to reduce emissions from de- forestation within Indonesia. Proceeding National Academy of Sciences, USA 109(4):1062–1067.

Booth, S.,M. Elchinger, G. Hill, J. Katz, J. Macknick, and J. Barnett (2014) Rantau Suli Integrated Project: A Green Prosperity Model Project National Renewable Energy Laboratory.

Cacho O. B. Leimona, Erwidodo and R. Stringer (2015) Landscape policy, environmental services and climate change research opportunities, Background paper prepared for SRA, Contributing to Indonesia's Sustainable Agricultural Research Strategy,' (ADP/2014/011) Global Food Studies, University of Adelaide.

Cacho. O.J., Moss, J., Thornton, P., Herrero, M., Henderson, B., Bodirsky, B.L. 2016. Background paper on adaptation paths for vulnerable areas in support of SOFA 2016. Draft Report.

Cacho, O. J., Milne, S., Gonzalez, R., & Tacconi, L. 2014, 'Benefits and costs of deforestation by smallholders: Implications for forest conservation and climate policy', Ecological Economics, vol 107, pp. 321-332.

Coxhead, I. and B. Demeke (2004). Panel Data Evidence on Upland Agricultural Land Use in the Philippines: Can Economic Policy Reforms Reduce Environmental Damages? Am. J. Agr. Econ. (2004) 86 (5): 1354-1360.

Erwidodo and W. Maghraby. (2015). Research Priorities for Sustainable Agriculture in Indonesia, Background paper prepared for SRA, Contributing to Indonesia's Sustainable Agricultural Research Strategy,' (ADP/2014/011) Global Food Studies, University of Adelaide.

Garnett, T., M. C. Appleby, A. Balmford, I. J. Bateman, T. G. Benton, P. Bloomer, B. Burlingame, M. Dawkins, L. Dolan, D. Fraser, M. Herrero, I. Hoffmann, P. Smith, P. K. Thornton, C. Toulmin, S. J. Vermeulen, H. C. J. Godfray. (2013) Sustainable Intensification in Agriculture: Premises and Policies. Science, Vol 341 5 July 2013, pp 33-34.

Godfray, H.C.J, J. Beddington, I. Crute, L. Haddad, D. Lawrence, J. Muir, J. Pretty, S. Robinson, S.M. Thomas, C. Toulmin (2010). Food Security: The Challenge of Feeding 9 Billion People. Science 327, 812.

Gunawan, G., D. Sutjiningsih, H. Soeryantono, and W. Sulistioweni, (2013) Soil Erosion Estimation Based On Gis and Remote Sensing for Supporting Integrated Water Resources Conservation Management, International Journal of Technology (2013) 2: 147-156.

ICASEPS (Indonesian Center for Agricultural Socio Economic and Policy Studies (2008), "Analysis of Fertilizers' Supply and Demand in Indonesia, No. 3, published by ICASEPS, September.

Jones, J. W., Antle, J. M., Basso, B., Boote, K. J., Conant, R. T., Foster, I., Godfray, H. C. J., Herrero, M., Howitt, R. E., Janssen, S., Keating, B. A., Munoz-Carpena, R., Porter, C. H., Rosenzweig, C., & Wheeler, T. R. (2016). 'Brief history of agricultural systems modelling', Agricultural Systems. http://dx.doi.org/10.1016/j.agsy.2016.05.014.

Kondylis F, Mueller V, Sheriff G, Zhu S 2016, 'Do female instructors reduce gender bias in diffusion of sustainable land management techniques? Experimental evidence from Mozambique', World Development, vol. 78, pp. 436-449.

Leimona, B., Amaruzaman, S., Arifin, B., Yasmin, F., Hasan, F., Sprang, P., Dradjat, B., Agusta, H., Jaffee, S., Frias, J. (2015). Indonesia's 'Green Agriculture' strategies and policies: closing the gap between aspirations and application, World Agroforestry Centre and World Bank, Bogor.

Lusiana, B., van Noordwijk, M., Cadisch, G. 2012. Land sparing or sharing? Exploring livestock fodder options in combination with land use zoning and consequences for livelihoods and net carbon stocks using the FALLOW model. Agriculture, ecosystems & environment 159, 145-160.

Maryati, Sri , Tommy Firman, An Nisaa', Siti Humaira and Yovita Tisarda Febriani. 2020. Benefit Distribution of Community-Based Infrastructure: Agricultural Roads in Indonesia, Sustainability 2020, 12, 2085; doi:10.3390/su12052085

Mazvimavi, K & Twomlow, S 2009, 'Socioeconomic and institutional factors influencing adoption of conservation farming by vulnerable households in Zimbabwe', Agricultural Systems, vol. 101, no. 1, pp. 20-29.

Nkala, P., Mango, N., Corbeels, M., Veldwisch, G.J., Huising, J., 2011. The conundrum of conservation agriculture and livelihoods in Southern Africa. African Journal of Agricultural Research 6 (24), 5520–5528.

OECD. (2012). OECD Review of Agricultural Policies: Indonesia 2012, Paris: OECD.

Pannell, D. R. S. Llewellyn. and M. Corbeels (2014) The farm-level economics of conservation agriculture for resource-poor farmers. Agriculture, Ecosystems and Environment 187 (2014) 52–64.

Pasha, R. (2012) The Internalization Cost of Conservation Practices of Potato Farming in Soraya Catchment (Case study in Igirmranak Village, Kejajar Sub-District, Wonosobo District). Masters Thesis, IPB.

Quincieu, E. (2015) Summary of Indonesia's Agriculture, Natural Resources, and Environment Sector Assessment. ADB Papers on Indonesia No. 08, October 2015, Asian Development Bank.

Rubin, D., and C. Manfre. 2014. Promoting gender-equitable agricultural value chains: Issues, Opportunities, and Next Steps. In Gender in agriculture and food security: Closing the knowledge gap, ed. A. Quisumbing, R. Meinzen-Dick, T. Raney, A. Croppenstedt, J.A. Behrman, and A. Peterman. New York, NY: Springer and FAO.

Suyanto, S, Permana, R, Khususiyah, N, Joshi, L. 2005, 'Land tenure agroforestry adoption and reduction of fire hazard in forest zone: A case study from Lampung, Sumatra, Indonesia' Agroforestry System, vol. 65, pp. 1-11.

Suyamto, D.A., Mulia, R., van Noordwijk, M., Luisana, B. 2009. FALLOW 2.0: manual and software. World Agroforestry Centre, Bogor.

UNDP United Nations Development Programme. 2015. Country programme document for Indonesia (2016-2020), New York, 4 September 2015.

van Noordwijk, M., 2002. Scaling trade-offs between crop productivity, carbon stocks and biodiversity in shifting cultivation landscape mosaics: the FALLOW model. Ecological Modelling 149, 113-126.

World Bank. 2009. Investing in a More Sustainable Indonesia. Country Environmental Analysis, Report No. 50762-ID, CEA Series, East Asia and Pacific Region, Washington, DC: World Bank.

World Bank. 2015. Indonesia Country Report 2015, World Bank: Washington D.C.

World Bank. 2016. Indonesia Economic Quarterly: Pressures easing, World Bank, Jakarta, October 2016.

World Bank. 2019. Aspiring Indonesia: Expanding the Middle Class. World Bank: Washington D.C.

World Bank. 2020. Indonesia Agro-Value Chain Assessment, Background Paper: An Exploratory Overview of Agriculture Finance in Indonesia. 19 June 2020.

10.2 List of publications produced by project

Project Publications with hyperlinks

Journal Articles

Amaruzaman, S., Bardsley, D.K. & Stringer, R. (2023) Assessing Social Forestry Outcomes in Indonesia for Livelihood, Equity, and Conservation Goals. *Under Review Forest Policy and Economics.*

Amaruzaman, S., Bardsley, D.K. & Stringer, R. 2023. Analysing Agricultural Policy Outcomes in the Uplands of Indonesia: A Multi-dimensional Sustainability Assessment, *Sustainable Development*. [Q1, IF 8.56]

F Nurfatriani, Erwidodo, H Tarigan, H W Perkasa, (2022). The role of the Community Forest Management and Social Forestry Programs in Increasing Farmers' Income and Conserving Forests in the Upper Citarum Watershed, West Java. *Under Review Journal of International Forestry Review*

Amaruzaman, S., Bardsley, D.K. & Stringer, R. (2022) Reflexive policies and the complex socio-ecological systems of the upland landscapes in Indonesia. *Agriculture and Human Values.* (2022). https://doi.org/10.1007/s10460-021-10281-3. [Q1, IF 3.29].

Sumaryanto, Susilowati S H, Nurfatriani F, Tarigan H, Erwidodo, Sudaryanto T and Perkasa H W (2022). Determinants of Farmers' Behavior towards Land Conservation. *Land 11, 1827*. https://doi.org/10.3390/ land11101827.

Qanti, S.R., Peralta, A. & Zeng, D. (2021). Social norms and perceptions drive women's participation in agricultural decisions in West Java, Indonesia. *Agriculture and Human Values*. https://doi.org/10.1007/s10460-021-10277-z. [Q1, IF 3.29].

Books

BK00238-21 Amaruzaman S, Isnurdiansyah, Nugraha M, Lusiana B, Leimona B. 2021. Profile of the production landscape of Pagar Alam: towards sustainable upland agriculture. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

BK00237-21 Isnurdiansyah, Amaruzaman S, Lusiana B, Leimona B. 2021. Production-landscape characteristics and vision through the lens of upland smallholders in Pagar Alam, Indonesia. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

IndoMod: *Modelling farmer decisions and landscape impacts for policy analysis*

This report explains the integration of household survey data, maps and secondary data into an integrated model, IndoMod, and applies the model to undertake policy analysis to estimate trade-offs between economic and environmental outcomes. The report is in draft form and not available yet for public release.

IndoMod: User Guide. This is a technical guide aimed at potential users of the model is art of a training package that includes five step-by-step videos to explain how to calibrate and use the model. The guide is in draft form and not available for public release yet.

Takahashi, Y., Miwa, K., Amaruzaman, S., Rojo, V.n., Vilá, B., Gupta, H., Takeuchi, K., 2022. Landscape approach for biodiversity, climate change and sustainable development co-benefits. International Forum for Sustainable Asia and the Pacific (ISAP) 2021

Project Briefs English

PB #1 Introducing the IndoGreen Research Project

PB #2 The Bandung and West Bandung Study Site Survey Design

PB #3 Pagar Alam Study Site Survey Design

PB #4 How Policies and Projects Influence Land Management Choices

PB #5 Land-use Transitions in the Bandung/West Bandung Study Site

PB #6 Land-use Transitions in the Pagar Alam Study Site

PB #7 The impact of SWC practices on household income of smallholder farmers

PB #8 Are Agroforestry Systems Profitable in Pagar Alam?

PB #9 How Socioeconomic and Landscape Diversity Influence Policy and Program Outcomes

PB #10 Social Norms and Women's Participation in Agricultural Decision Making

PB #11 The social, demographic, and economic drivers of adopting SWC practices

PB #12 Selecting Alternative Policies/Programs to Promote Landscape Change

PB #13 Pagar Alam Survey Results: Farming Systems

PB #14 Pagar Alam Survey Results: Farm Profits

PB #15 Pagar Alam Survey Results: Conservation Practices

PB #16 Bandung/West Bandung Survey Results: Farming Systems

PB #17 Bandung/West Bandung Survey Results Farm Clusters

PB #18 Forest Tenure and Social Forestry Programs

PB #19 Addressing Gender Barriers to Promote Landscape Change

PB #20 Can coffee value chain interventions support welfare and environmental outcomes?

PB #21 Women's Participation in Farming Decisions in Pagar Alam

PB #22 Differences in Spousal Perceptions of Intrahousehold Decision Making

PB #23 Modelling coffee value chain interventions to achieve land use change on upland slopes

PB #24 Modelling a Community Forestry Annuity Scheme

PB #25 Women in Coffee Value Chain

PB #26 GenRiver Model Outcome in Bandung

PB #27 Farm Household Heterogeneity Income and Land

Working Papers

WP #1 Rural transformation in the upper Citarum watershed and its implication to soil conservation practices. S H Susilowati, T Sudaryanto, H W Perkasa, Sumaryanto, and H Tarigan.

WP #2 Effects of soil and water conservation practices on rural household livelihood in upland Sumatera, Indonesia. Ying Xu

WP #3. Characteristics of Vegetable Farming and Conservation Practices and their Impacts on Productivity and Profits in the Upper Citarum Watershed, West Java. S H Susilowati, Sumaryanto, Erwidodo, Tahlim Sudaryanto, Satria Astana Henri W Perkasa.

WP #4. The potential impacts of farm households' characteristics on soil erosion in the upper area of Citarum watershed, west java, Indonesia. Satria Astana, Erwidodo, Henri W Perkasa, S H Susilowati

WP #5 Adoption and impact of soil and water conservation practices on farm performance in Indonesia Muhammad. Masood Azeem, Daniel Gregg, Oscar Cacho, and Randy Stringer

WP #6 Role of women in agricultural decision making in the upstream area of the Citarum watershed, West Java. Herlina Tarigan, Erwidodo, Henri W Perkasa, and Sri Hery

WP #7 Analysis of soil and water conservation practices by community throughout the Upper Citarum River Watershed: motivational, technical and institutional aspects. Fitri Nurfatriani, Henri W Perkasa, Satria Astana and Erwidodo

WP #8 The complex reality of natural resource policies in the uplands of Indonesia. Sacha Amaruzaman, Douglas Bardsley, and Randy Stringer

WP #9 Simulating the effect of change in land cover and rainfall in Upper Citarum Watershed: calibration and sensitivity analysis of Genriver model. Lisa Tanika, Betha Lusiana, Adis Hendriatna.

WP #10 The role in agricultural decision making in the upper Citarum watershed, Indonesia. Tarigan, Erwidodo, H W Perkasa and S H Susilowati IOP Conference Series: Earth and Environmental Science, Volume 892, 1st International Conference on Agriculture, Natural Resources, and Rural Development 27-28 July 2021, Bogor, Indonesia.

WP #11 Analysis of soil and water conservation practices by community throughout the Upper Citarum River Watershed: motivational, technical and institutional aspects. H W Perkasa, F Nurfatriani, S Astana and Erwidodo IOP Conference Series: Earth and Envir Environmental Science, Volume 917, The 6th International Conference of Indonesia Forestry Researchers - Stream 4 Engaging Social Economic of Environment and Forestry, Better Social Welfare 08 September 2021, Bogor, Indonesia.

WP #12 The potential impacts of farm households' characteristics on soil erosion in the upper area of Citarum Watershed, West Java, Indonesia. Satria Astana, Erwidodo, Henri W Perkasa, Sri Hery

WP #13 Rural transformation in the upper Citarum watershed and its implication to soil conservation practices. S H Susilowati, T Sudaryanto, H W Perkasa, Sumaryanto and H Tarigan. IOP Conference Series: Earth and Environmental Science, Volume 892, 1st International Conference on Agriculture, Natural Resources, and Rural Development 27-28 July 2021, Bogor, Indonesia

WP #14 Characteristics of Vegetable Farming and Conservation Practices and their Impacts on Productivity and Profits in the Upper Citarum Watershed, West Java. Sri Hery Susilowati, Henri W Perkasa, Satria Astana, Fajri Shoutun Nida, Erwidodo

WP #15 Perception and adaptation of agroforestry farmers in Upper Citarum Watershed to climate change. Sumaryanto, F Nurfatriani, S Astana and Erwidodo., IOP Conference Series: Earth and Environmental Science, Volume 917, The 6th International Conference of Indonesia Forestry Researchers - Stream 4 Engaging Social Economic of Environment and Forestry, Better Social Welfare 08 September 2021, Bogor, Indonesia.

WP #16 Determinants of Farmers' Behavior towards Land Conservation Practices in the Upper Citarum Watershed, West Java, Indonesia. Sumaryuanto et al. (Land Journal-MPDI).

WP #17. The Impacts of Climate Change, Land-use and conservation
Practices in Upstream Citarum Watershed on Sedimentation and Lifespan of the Saguling Reservoir, West Java. Erwidodo, Lisa Tanika, Sumaryanto, Tahlim Sudaryanto, Sri H. Susilowati, Herlina Tarigan, Resty P. Perdana, Fitri Nurfatriani, Henri W. Perkasa.

WP#18 Simulating the effect of change in land cover and rainfall in Upper Citarum Watershed: calibration and sensitivity analysis of GenRiver model. Tanika L, Lusiana B, Hendriatna A. 2020. Working paper no. 310. Bogor, Indonesia: World Agroforestry (ICRAF).

WP#18. Tanika L, Lusiana B, Hendriatna A. 2020. Simulasi Dampak Perubahan Tutupan Lahan dan Iklim di DAS Citarum Hulu dengan Model GenRiver: Kalibrasi model dan analisa sensitivitas. Working paper no. 309. Bogor, Indonesia: World Agroforestry (ICRAF) Southeast Asia Regional Program

WP#19 'It is How it is vs Who Knows Best', Qanti, S. Poster Presentation for the 31st International Conference of Agricultural Economist (ICAE) held by IAAE from 17-31 Aug 2

WP#20 Enhancing Adaptation for Improving Upland Livelihood and Landscape: An insight from Sumatra, Indonesia. Amaruzaman, S. 2021. Presentation in the *International Forum for Sustainable Asia and the Pacific (ISAP) 2021.* Pacifico Yokohama, Japan and Online, 2 December 2021

WP#21 Sara Qanti, IndoGreen PhD student's Three Minute Thesis Presentation: Women's participation in agricultural decision-making in the Bandung Study Site. (https://vimeo.com/575614082)

WP#22 Profit variability of vegetable farming in the Upper Citarum Watershed, West Java, Indonesia. S H Susilowati, R P Perdana, Sumaryanto, Erwidodo, T Sudaryanto, H W Perkasa, A Agustian. (Submitted for the 4th International Conference Food Security and Sustainable Agriculture in Tropics – FSSAT, virtual conference February 15th – 16th, 2023)

WP#23 Sustainable Agricultural Systems Upstream of the Citarum Watershed: Spcial, Economic and Environmental Implications. H Tarigan Erwidodo HW Perkasa and Whidiantini. First Asian PGPR Indonesian Chapter International e-Conference 28-30 August 2021, Denpasar, Indonesia (Virtual). Volume 2022.

User Manuals for Project Developed Land Use Planning Decision Support Models

IndoMod: User Guide.

KopiMod Crop Choice Excel Based Decision Making Tool

Tanika L, Lusiana B, Erwidodo, Perkasa H. 2022. Panduan Pemodelan Kinerja Daerah Aliran Sungai Menggunakan GenRiver. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Program.

Training Videos to Accompany IndoMod Manual for Online Learning

IndoMod Session 1

IndoMod Session 2

IndoMod Session 3

IndoMod Session 4

IndoMod Session 5

ICRAF and University of Adelaide Web Blogs

Preliminary Visit and Survey process

Sustainable Coffee Workshop for Local Coffee Farmers, in collaboration with private sectors (NedCoffee and Starbucks)

An Instagram posting on the ecosystem services and valuation training

Videos and Online Presentations

Three online videos by Professor Oscar Cacho explaining the Upper Citarum Land-use Planning Support Tools

Farm households and farming systems in the West Java study site https://www.dropbox.com/s/se2r6r5s0kj4h6h/Indomod_FarmSys.mp4?dl=0 Presents an analysis of the household and plot data collected through a survey in the study site. It concludes with a simple land-use policy example and demonstrates how the cost of the policy may be estimated using the data. The shortcomings of the approach are explained.

Analysis of land cover changes in the Upper Citarum Basin: A policy perspective
https://www.dropbox.com/s/53o4110a941sbag/Map_analysis_Bandung.mp4?dl=0
Presents an analysis of map data obtained from secondary sources. Looks at land-cover changes for 2012, 2015 and 2018. It concludes with two simple land-use policy examples and demonstrates how the costs of the policies may be estimated using only map data, with no information on the households that manage the plots on the map. The shortcomings of the approach are explained.

Policy analysis using an integrated assessment model for the West Java study site
https://www.dropbox.com/s/al8oih2tdk77ppa/Indomod_policy_analysis.mp4?dl=0
Presents an overview of the integrated assessment model developed for the project, which combines data from videos 1 and 2 plus additional information on the costs of land-use transitions. The model is based on individual households maximising profit subject to resource constraints, plus additional constraints imposed by policies in certain areas of the landscape to reduce erosion rates. It concludes with an example showing how to run policy experiments containing any number of treatments. It demonstrates how to estimate trade-offs between environmental and economic variables and shows a method to estimate the potential cost of policies which overcome the problems identified in the previous two videos.

Two online videos by IndoGreen PhD student Daniel Hill explaining the crop choice decision making tool and the Forest annuity program

Modelling coffee value chain interventions to achieve land use change on upland slopes in the Citarum Basin
https://www.dropbox.com/s/n2i0evph7jsveq7/Dan_Hill_Coffee_Value_Chain.mp4?dl=0 Uses the model from video 3 and expands it to represents a policy that introduces a value chain intervention for coffee producers. It shows the effects of increasing coffee price premiums on landholder profits and erosion rates.

Modelling a Community Forest Annuity Scheme to achieve land use change on upland slopes in the Citarum Basin
https://www.dropbox.com/s/ptm0m2npkkkl760/Dan_Hill_Community_Forest.mp4?dl=0 Introduces a more refined policy aimed at providing incentives for farmers to adopt agroforestry systems based on timber trees. This could be a part of shade coffee system. The policy consists of an annuity that converts the final harvest value of timber into and annual cash flow for the farmer. It shows the effect of the annuity on producer welfare and erosion rates, it also estimates the potential cost of the policy.

Online Presentation by Randy Stringer providing background on the origin of IndoGreen

Seven minutes video highlighting the ICASEP's training workshop April 2022: Integrating good quality coffee production with honeybee. IndoGreen coffee training in Lebakmuncang Village, Bandung District and Mukapayung Village, West Bandung District

Online presentations by PhD Students

Sara Qanti, IndoGreen PhD student's Three Minute Thesis Presentation: Women's participation in agricultural decision-making (https://vimeo.com/575614082)

Sara Qanti, Social Norms and perceptions on women participation in agricultural decisions: The Case of West Java AARES Conference February 2021 (https://www.dropbox.com/s/pjehvz7x2m6ttn9/1457_AARES%202021_Sara%20Qanti_final.mp4?dl=0)

Sara Qanti, Petani, perempuan, dan pengambilan keputusan (Farmers, women, and decision making), Guest speaker for Indonesian Students Association in Australia (https://www.instagram.com/tv/CcKVeflB5Kt/?hl=en)

Sara Qanti, Penggunaan pupuk, konservasi tanah dan air, dan pelibatan perempuan (Fertiliser use, water and soil conservation, and women's participation), Seminar Series Forum Kajian Pembangunan hosted by Center for Indonesian Policy Studies and National Research and Innovation Agency (https://youtu.be/R6GIYgeKy-M)

Amaruzaman, S. 2021. Enhancing Adaptation for Improving Upland Livelihood and Landscape: An insight from Sumatra, Indonesia. Presentation in the *International Forum for Sustainable Asia and the Pacific (ISAP) 2021.* Pacifico Yokohama, Japan and Online, 2 December 2021

Online Presentations for Working Papers

Characteristics of Vegetable Farming and Conservation Practices and their Impacts on Productivity and Profits in the Upper Citarum Watershed, West Java. Sri Hery Susilowati, Henri W Perkasa, Satria Astana, Fajri Shoutun Nida, Erwidodo

F Nurfatriani, Erwidodo, H Tarigan, H W Perkasa, The role of the Community Forest Management and Social Forestry Programs in Increasing Farmers' Income and Conserving Forests in the Upper Citarum Watershed, West Java

Determinants of Farmers' Behavior towards Land Conservation Practices in the Upper Citarum Watershed, West Java, Indonesia. Sumaryuanto et al.

The Impacts of Climate Change, Land-use and conservation
Practices in Upstream Citarum Watershed on Sedimentation and Lifespan of the Saguling Reservoir, West Java. Erwidodo et al.

Media Monitoring includes:

https://sumatra.bisnis.com/read/20220412/534/1522210/petani-kopi-pagaralam-butuh-penguatan-akses-pasar

https://www.liputan6.com/regional/read/4939291/hasil-riset-pertanian-berkelanjutan-indogreen-jadi-acuan-kebijakan-di-pagar-alam

https://sumsel.antaranews.com/berita/634637/peneliti-icraf-sarankan-pengembangan-agroforestri-pada-perkebunan-kopi-pagaralam

https://www.merdeka.com/peristiwa/kopi-pagaralam-citra-rasa-robusta-yang-terkendala-akses-pasar.html

https://palembang.tribunnews.com/2022/04/12/dukung-pagar-alam-menuju-besemah-hijau-indogreen-serahkan-hasil-penelitian-lanskap-pertanian?page=all https://id.berita.yahoo.com/kopi-pagaralam-citra-rasa-robusta-120154942.html

https://www.timesindonesia.co.id/read/news/405544/indogreen-serahkan-hasil-penelitian-ke-pemkot-pagaralam

Pagar Alam Info Briefs

PB00194-21 Isnurdiansyah, Amaruzaman S, Lusiana B, Leimona B. 2021. Panen, Pascapanen dan Pemasaran Kopi Robusta di Kota Pagar Alam. Brief No. 114. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

PB00193-21 Isnurdiansyah, Amaruzaman S, Lusiana B, Leimona B. 2021. Teknik Konservasi Tanah dan Air Lahan Pertanian Pagar Alam. Brief No. 115. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

PB00195-21 Isnurdiansyah, Amaruzaman S, Lusiana B, Nugraha M, Leimona B. 2021. Dinamika dan visi penggunaan lahan petani di Kota Pagar Alam. Brief No. 116. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

PB00196-22 Lusiana B, Isnurdiansyah, Amaruzaman S, Leimona B. 2022. Peran Perempuan dalam Pertanian di Pagar Alam. Brief no. 117. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Program.

Brief-119-23 Isnurdiansyah, Amaruzaman S, Lusiana B, Leimona B. 2023. Harvesting, Postharvesting, and Marketing of Robusta Coffee in Pagar Alam. Brief No. 119. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

Brief-120-23 Isnurdiansyah, Amaruzaman S, Lusiana B, Leimona B. 2023. Agricultural Land Soil and Water Conservation Techniques in Pagar Alam. Brief No. 120. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

Brief-121-23 Isnurdiansyah, Amaruzaman S, Lusiana B, Nugraha M, Leimona B. 2023. Farmer Land Use Vision and Dynamics in Pagar Alam City. Brief No. 121. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

Brief-122-23 Lusiana B, Isnurdiansyah, Amaruzaman S, Leimona B. 2023. Agriculture and Women in Pagar Alam. Brief no. 122. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Program.

Posters (Bahasa)

Profil #1 Karakteristik Petani Kecamatan Dempo Selatan, Kota Pagar Alam, Provinsi Sumatera Selatan

Profil #2 Karakteristik Petani Kecamatan Dempo Utara, Kota Pagar Alam, Provinsi Sumatera Selatan

Profil #3 Karakteristik Petani Kecamatan Dempo Tengah, Kota Pagar Alam, Provinsi Sumatera Selatan

Infographics (Bahasa)

INGRAPH #1 Karakteristik Sosial Masyarakat dan Potensi Pengembangan Sumber Daya Manusia Kecamatan Dempo Selatan

INGRAPH #2 Karakteristik Ekonomi dan Bisnis Petani Kecamatan Dempo Selatan

INGRAPH #3 Karakteristik Pengelolaan Lahan Pertanian Kecamatan Dempo Selatan

INGRAPH #4 Karakteristik Sosial Masyarakat dan Potensi Pengembangan Sumber Daya Manusia Kecamatan Dempo Utara

INGRAPH #5 Karakteristik Ekonomi dan Bisnis Petani Kecamatan Dempo Utara

INGRAPH #6 Karakteristik Pengelolaan Lahan Pertanian Kecamatan Dempo Utara

INGRAPH #7 Karakteristik Sosial Masyarakat dan Potensi Pengembangan Sumber Daya Manusia Kecamatan Dempo Tengah

INGRAPH #8 Karakteristik Ekonomi dan Bisnis Petani Kecamatan Dempo Tengah

INGRAPH #9 Karakteristik Pengelolaan Lahan Pertanian Kecamatan Dempo Tenga

PO00419-21 Isnurdiansyah, Amaruzaman S, Lusiana B, Leimona B. 2021. *Profil Karakteristik Petani Kecamatan Dempo Utara Kota Pagar Alam, Provinsi Sumatera Selatan*. Poster. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

LE00294-21 Amaruzaman S, Isnurdiansyah, Nugraha M, Lusiana B, Leimona B. 2021. *Profil Karakteristik Petani Kecamatan Dempo Tengah Kota Pagar Alam, Provinsi Sumatera Selatan*. Leaflet. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

LE00293-21 Amaruzaman S, Isnurdiansyah, Nugraha M, Lusiana B, Leimona B. 2021. *Profil Karakteristik Petani Kecamatan Dempo Selatan Kota Pagar Alam, Provinsi Sumatera Selatan*. Leaflet. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

BK00238-21 Amaruzaman S, Isnurdiansyah, Nugraha M, Lusiana B, Leimona B. 2021. *Profile of the production landscape of Pagar Alam: towards sustainable upland agriculture*. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

Technical Reference Papers

TR #1 Soil Erosion Papers for IndoGreen

TR #2 Natural Resources Literature Review

TR #3 Inventory of National and local Policy Initiatives in the Bandung Study Site

TR #4 Social Forestry and Community Forestry in Indonesia

Background Papers

BP #1 Sustainable agriculture program in the BRICS: gaps and lessons from Indonesia. Laura Bateman, Erwidodo, Wahida, Randy Stringer, Oscar Cacho, and Beria Leimona

BP #2 Landscape policy, environmental services and climate change: research opportunities. Oscar Cacho, Beria Leimona, Erwidodo, and Randy Stringer

BP #3 Estimating the cost of strengthening ecosystem connectivity in an agricultural landscape in central Sumatra. Laura Bateman, Dale Yi, Oscar Cacho, and Randy Stringer

BP #4 Testing Research Methods for Understanding Household Land Management Practices in Upland Landscapes. Laura Bateman, Oscar Cacho, Henri Perkasa, Thomas Barrano, Dale Yi, and Randy Stringer

11 Appendixes

11.1 Mapping project papers and policy briefs to activities

Outputs by Activity

Objective 1: Mapping papers to objectives/activities	
Activity 1	**Project Briefs**
Survey Preparation and Sample Design	PB #1 Introducing the Project PB #2 Bandung/West Bandung Survey Design PB #3 Pagar Alam Study Site Survey Design
	Online Presentation: The origin of IndoGreen (18 minutes)
Activity 2	**Project Briefs**
Evaluate land use decisions & impacts using household survey	PB #5 Land-use Transitions in Bandung/West Bandung. PB #6 Land-use Transitions in the Pagar Alam. PB #7 SWC practices and smallholder income. PB #13 Pagar Alam Survey Results: Farming Systems PB #14 Pagar Alam Survey Results: Farm Profits. PB #15 Pagar Alam Survey Results: Conservation Practices. PB #16 Bandung/West Bandung Results: Farming Systems. PB #17 Bandung/West Bandung Results Farm Clusters.
	Journal Articles
	Sumaryanto et. al. (2022). Determinants of Farmers' Behavior towards Land Conservation. *Land. Land 2022, 11, 1827.* *https://doi.org/10.3390/land11101827*
	Working Papers
	WP #1 Rural transformation in the upper Citarum watershed and its implication to soil conservation practices. WP #2 Effects of soil and water conservation practices on rural household livelihood in upland Sumatera, Indonesia. WP #3. Characteristics of Vegetable Farming and Conservation Practices and their Impacts on Productivity and Profits in the Upper Citarum Watershed. WP #4. The potential impacts of farm households' characteristics on soil erosion in the upper area of Citarum watershed, West Java, Indonesia. WP #5 Adoption and impact of soil and water conservation practices on farm performance in Indonesia.

	WP #7 Analysis of soil and water conservation practices by community throughout the Upper Citarum River Watershed: motivational, technical, and institutional aspects. WP #12 The potential impacts of farm households' characteristics on soil erosion in the upper area of Citarum Watershed, West Java. WP #14 Characteristics of Vegetable Farming and Conservation Practices and their Impacts on Productivity and Profits in the Upper Citarum Watershed, West Java. WP#18 10.5716/WP20049.PDF. The GenRiver Model: Simulating the effect of change in land cover and rainfall in Upper Citarum Watershed: calibration and sensitivity analysis of GenRiver model. ICRAF Working paper no. 310. WP#22 Profit variability of vegetable farming in the Upper Citarum Watershed, West Java, Indonesia.
	Manuscripts
	BK00238-21 Amaruzaman S, Isnurdiansyah, Nugraha M, Lusiana B, Leimona B. 2021. Profile of the production landscape of Pagar Alam: towards sustainable upland agriculture. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program. BK00237-21 Isnurdiansyah, Amaruzaman S, Lusiana B, Leimona B. 2021. Production-landscape characteristics and vision through the lens of upland smallholders in Pagar Alam, Indonesia. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.
Activity 3	**Project Briefs**
Policy Dialogues **Community Engagement**	PB #4 How Policies & Projects Influence Land Use Choices. PB #9 How Diversity Influences Policy Outcomes PB #8 Are Agroforestry Systems Profitable in Pagar Alam? PB #11 The drivers of adopting SWC practices. PB #12 Alternative Policies and Landscape Change PB #18 Forest Tenure and Social Forestry Programs PB #20 Coffee chains, welfare, and the environment. PB #27 Household Heterogeneity Income and Land
	Journal Articles
	Amaruzaman, S. et. al (2023) Assessing Social Forestry Outcomes in Indonesia for Livelihood, Equity, and Conservation Goals. *Under Review Forest Policy and Economics.* Amaruzaman, et al. (2023) Analysing Agricultural Policy Outcomes in the Uplands of Indonesia: A Multi-dimensional Sustainability Assessment, *Sustainable Development.*10 January 2023 https://doi.org/10.1002/sd.2494 F Nurfatriani et. al. (2022). The role of the Community Forest Management and Social Forestry Programs in Increasing Farmers'

	Income and Conserving Forests in the Upper Citarum Watershed, West Java. *Under Review Journal of International Forestry Review* Amaruzaman, S. et. al. (2022). Reflexive policies and the complex socio-ecological systems of the upland landscapes in Indonesia. June 2022 Agriculture and Human Values 39(4) DOI:10.1007/s10460-021-10281-3
	Working Papers
	WP #8 The complex reality of natural resource policies in the uplands of Indonesia. WP #13 Rural transformation in the upper Citarum watershed and its implication to soil conservation practices. WP #15 Perception and adaptation of agroforestry farmers in Upper Citarum Watershed to climate change. WP #17. The Impacts of Climate Change, Land-use and conservation practices in Upstream Reservoir, West Java. WP#23 Sustainable Agricultural Systems Upstream of the Citarum Watershed: Special, Economic and Environmental Implications.
	Manuscripts
	BK00238-21 Amaruzaman S, Isnurdiansyah, Nugraha M, Lusiana B, Leimona B. 2021. Profile of the production landscape of Pagar Alam: towards sustainable upland agriculture. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program. BK00237-21 Isnurdiansyah, Amaruzaman S, Lusiana B, Leimona B. 2021. Production-landscape characteristics and vision through the lens of upland smallholders in Pagar Alam, Indonesia. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program. Takahashi, Y., Miwa, K., Amaruzaman, S., Rojo, V.n., Vilá, B., Gupta, H., Takeuchi, K., 2022. Landscape approach for biodiversity, climate change and sustainable development co-benefits.
	Video for Policy and Project Design Network
	Video: The role of the community Forest Management and Social Forsetry Programs in Increasing Farmers' Income and Conserving Forests in the Upper Citarum Watershed, West Java Video: Characteristics of Vegetable Farming and Conservation Practices and their Impacts on Productivity and Profits in the Upper Citarum Watershed, West Java. Sri Hery Susilowati, Henri W Perkasa, Satria Astana, Fajri Shoutun Nida, Erwidodo Video: The role of the Community Forest Management and Social Forestry Programs in Increasing Farmers' Income and Conserving Forests in the Upper Citarum Watershed, West Java F, Nurfatriani, Erwidodo, H Tarigan, H W Perkasa.

	Video: Determinants of Farmers' Behavior towards Land Conservation Practices in the Upper Citarum Watershed, West Java, Indonesia. Sumaryuanto et al.
Activity 4	**Project Briefs**
Gender Analysis	PB #10 Women's Participation Decision Making. PB #19 Addressing Gender Barriers to Landscape Change. PB #21 Women's Participation in Farm Decisions in Pagar Alam PB #22 Spousal Perceptions of Decision Making PB #25 Women in Coffee Value Chains.
	Journal Articles
	Qanti, S.R et al. (2021). Social norms and perceptions drive women's participation in agricultural decisions in West Java, Indonesia. *Agriculture and Human Values.*
	Working Papers
	WP #6 Role of women in agricultural decision making in the upstream area of the Citarum watershed, West Java. WP #10 The role in agricultural decision making in the upper Citarum watershed, Indonesia. WP#19 'It is How it is vs Who Knows Best', Qanti, S. Poster Presentation for the 31st International Conference of Agricultural Economist (ICAE, IAAE)

Objective 2 & 3: Mapping papers to objectives/activities

Activity	**Online Presentation**
Land Use Planning Support Tools	The IndoMod and IndoMap Support Tools: Farm households and farming systems in the West Java study site. https://www.dropbox.com/s/se2r6r5s0kj4h6h/Indomod_FarmSys.mp4?dl=0 The IndoMap Support Tool: Analysis of land cover changes in the Upper Citarum Basin: A policy perspective. https://www.dropbox.com/s/53o4110a941sbag/Map_analysis_Bandung.mp4?dl=0 The IndoMod Support Tool: Policy analysis using an integrated assessment model for the West Java study site https://www.dropbox.com/s/al8oih2tdk77ppa/Indomod_policy_analysis.mp4?dl=0

	Working Papers
	The GenRiver Model: Simulating the effect of change in land cover and rainfall in Upper Citarum Watershed: calibration and sensitivity analysis of GenRiver model. Working paper no. 310. DOI: 10.5716/WP20049.PDF.
	Manuscripts
	Modelling Farmer decisions and landscape impacts for policy analysis. This report explains the integration of household survey data, maps and secondary data into an integrated model, IndoMod, and applies the model to undertake policy analysis to estimate trade-offs between economic and environmental outcomes. The report is in draft form and not available yet for public release
	Manuals and User Guides
	Integrated assessment model: User Guide. 2022. This is a technical guide aimed at potential users of the model. It will be part of a training package that includes step-by-step videos to explain how to calibrate and use the model. The guide is in draft form and not available for public release yet. The KopiMod User Manual: Crop Choice Excel Based Decision Making Tool
	Project Briefs
	PB #23 IndoMod: Modelling coffee value chain interventions to achieve land use change on upland slopes. PB #24 IndoMod: Modelling a Community Forestry Annuity Scheme
Activity	**Training Reports**
Coffee Value Chain Interventions	Pagar Alam Sustainable Coffee Workshop for Local Coffee Farmers, in collaboration with private sectors (NedCoffee and Starbucks). Seven minutes video highlighting the ICASEP's training workshop April 2022: Integrating good quality coffee production with honeybee. IndoGreen coffee training in Lebakmuncang Village, Bandung District and Mukapayung Village, West Bandung District. PB00194-21 2021. Panen, Pascapanen dan Pemasaran Kopi Robusta di Kota Pagar Alam. Brief No. 114. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program.

Activity	PhD Student Publications
Capacity Building	Sara Qanti, IndoGreen PhD student's Three Minute Thesis Presentation: Women's participation in agricultural decision Making (https://vimeo.com/575614082) Sara Qanti, Social Norms and perceptions on women participation in agricultural decisions: The Case of West Java AARES Conference February 2021 (https://www.dropbox.com/s/pjehvz7x2m6ttn9/1457_AARES%202021_Sara%20Qanti_final.mp4?dl=0) Sara Qanti, Petani, perempuan, dan pengambilan keputusan (Farmers, women, and decision making), Guest speaker for Indonesian Students Association in Australia (https://www.instagram.com/tv/CcKVeflB5Kt/?hl=en) Sara Qanti, Penggunaan pupuk, konservasi tanah dan air, dan pelibatan perempuan (Fertiliser use, water and soil conservation, and women's participation), Seminar Series Forum Kajian Pembangunan hosted by Center for Indonesian Policy Studies and National Research and Innovation Agency (https://youtu.be/R6GIYgeKy-M) Amaruzaman, S. 2021. Enhancing Adaptation for Improving Upland Livelihood and Landscape: An insight from Sumatra, Indonesia. Presentation in the *International Forum for Sustainable Asia and the Pacific (ISAP) 2021.* Pacifico Yokohama, Japan and Online, 2 December 2021 Amaruzaman, S., Bardsley, D.K. & Stringer, R. (2023) Assessing Social Forestry Outcomes in Indonesia for Livelihood, Equity, and Conservation Goals. *Under Review Forest Policy and Economics.* Amaruzaman, S., Bardsley, D.K. & Stringer, R. 2023. Analysing Agricultural Policy Outcomes in the Uplands of Indonesia: A Multi-dimensional Sustainability Assessment, *Sustainable Development*. [Q1, IF 8.56]. Qanti, S.R., Peralta, A. & Zeng, D. (2021). Social norms and perceptions drive women's participation in agricultural decisions in West Java, Indonesia. *Agriculture and Human Values*. https://doi.org/10.1007/s10460-021-10277-z. [Q1, IF 3.29]. Dan Hill: KopiMod Crop Choice Excel Based Decision Making Tool Dan Hill. Video Presentation: Modelling coffee value chain interventions to achieve land use change on upland slopes in the Citarum Basin https://www.dropbox.com/s/n2i0evph7jsveq7/Dan_Hill_Coffee_Value_Chain.mp4?dl=0 Uses IndoMod to represents a policy that introduces a value chain intervention for coffee producers. It shows the effects of increasing coffee price premiums on landholder profits and erosion rates. Dan Hill. Video Presentation: Modelling a Community Forest Annuity Scheme to achieve land use change on upland slopes in the Citarum Basin https://www.dropbox.com/s/ptm0m2npkkkl760/Dan_Hill_Community_Forest.mp4?dl=0 Introduces a more refined policy aimed at providing incentives for farmers to adopt agroforestry systems based on timber trees.

Activity	Bahasa Project Communications Materials
Community Engagement and Outreach	**Working Papers (Bahasa)** PB00194-21 2021. Panen, Pascapanen dan Pemasaran Kopi Robusta di Kota Pagar Alam. Brief No. 114. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program. PB00193-21. 2021. Teknik Konservasi Tanah dan Air Lahan Pertanian Pagar Alam. Brief No. 115. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program. PB00195-21 2021. Dinamika dan visi penggunaan lahan petani di Kota Pagar Alam. Brief No. 116. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Country Program. PB00196-22 2022. Peran Perempuan dalam Pertanian di Pagar Alam. Brief no. 117. Bogor, Indonesia: World Agroforestry (ICRAF) Indonesia Program. **Posters (Bahasa)** Profil #1 Karakteristik Petani Kecamatan Dempo Selatan, Kota Pagar Alam, Provinsi Sumatera Selatan Profil #2 Karakteristik Petani Kecamatan Dempo Utara, Kota Pagar Alam, Provinsi Sumatera Selatan Profil #3 Karakteristik Petani Kecamatan Dempo Tengah, Kota Pagar Alam, Provinsi Sumatera Selatan **Infographics (Bahasa)** INGRAPH #1 Karakteristik Sosial Masyarakat dan Potensi Pengembangan Sumber Daya Manusia Kecamatan Dempo Selatan INGRAPH #2 Karakteristik Ekonomi dan Bisnis Petani Kecamatan Dempo Selatan INGRAPH #3 Karakteristik Pengelolaan Lahan Pertanian Kecamatan Dempo Selatan INGRAPH #4 Karakteristik Sosial Masyarakat dan Potensi Pengembangan Sumber Daya Manusia Kecamatan Dempo Utara INGRAPH #5 Karakteristik Ekonomi dan Bisnis Petani Kecamatan Dempo Utara INGRAPH #6 Karakteristik Pengelolaan Lahan Pertanian Kecamatan Dempo Utara INGRAPH #7 Karakteristik Sosial Masyarakat dan Potensi Pengembangan Sumber Daya Manusia Kecamatan Dempo Tengah INGRAPH #8 Karakteristik Ekonomi dan Bisnis Petani Kecamatan Dempo Tengah INGRAPH #9 Karakteristik Pengelolaan Lahan Pertanian Kecamatan Dempo Tenga

	Videos for Project Design and Policy Networks
	Video: The role of the community Forest Management and Social Forsetry Programs in Increasing Farmers' Income and Conserving Forests in the Upper Citarum Watershed, West Java Video: Characteristics of Vegetable Farming and Conservation Practices and their Impacts on Productivity and Profits in the Upper Citarum Watershed, West Java. Sri Hery Susilowati, Henri W Perkasa, Satria Astana, Fajri Shoutun Nida, Erwidodo Video: The role of the Community Forest Management and Social Forestry Programs in Increasing Farmers' Income and Conserving Forests in the Upper Citarum Watershed, West Java F, Nurfatriani, Erwidodo, H Tarigan, H W Perkasa. Video: Determinants of Farmers' Behavior towards Land Conservation Practices in the Upper Citarum Watershed, West Java, Indonesia. Sumaryuanto et al.