ENVIRONMENTAL EVIDENCE

SYSTEMATIC REVIEW PROTOCOL　　　　　　　　　**Open Access**

Socioeconomic and environmental effects of China's Conversion of Cropland to Forest Program after 15 years: a systematic review protocol

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Abstract

Background: Agricultural activities on sloping lands have historically led to forest loss and degradation in China which, coupled with industrial pressures on the environment, were deemed responsible for catastrophic flooding events in the late 1990s. After these events, China's forest policy underwent a significant reorientation towards ecological conservation and rural development, a process epitomized by the Conversion of Cropland to Forest Program (CCFP). Launched in 1999, the CCFP integrates both socioeconomic and environmental objectives with the aim of reforesting smallholder cropland on sloping lands, while compensating farmers with payments for their lost income. Following 15 years of implementation, it is timely to conduct a comprehensive assessment of the state of knowledge about the CCFP's impacts on human populations and the environment.

Methods/design: The primary research question asks "What socioeconomic and environmental effects has the Conversion of Cropland to Forest Program had on human populations and land resources during its first 15 years in China?" We use a theory of change and a Population-Intervention-Comparator-Outcome (PICO) framework to structure our systematic review, where populations of interest consist of both human populations and land resources targeted by the program, while the intervention of interest is the CCFP as defined by its component activities, including compensatory subsidies, skill-training, and enforcement with field checks. Outcomes are defined as both the socioeconomic and environmental impacts of the program. We will conduct a search for relevant English and Chinese language literature on Scopus, Web of Science, CAB Abstracts, AGRIS (FAO), and the China National Knowledge Infrastructure. Search results will be screened for relevance in a two stage process (titles and abstracts, followed by full texts) based on predefined eligibility criteria, and then further assessed for potential sources of bias. Extraction of data from those studies that have passed full-text screening will follow a coding protocol based on the PICO framework, and quantitative and qualitative analyses of the extracted data will be conducted and synthesized. Finally, a narrative report will present the findings of the review, alongside a geographic map illustrating the coverage of included studies compared with the actual implementation area of the CCFP.

Keywords: Conversion of Cropland to Forest Program, Sloping Land Conversion Program, Grain for Green, Payment for ecosystem services, Land use change, Afforestation, Soil erosion, Flooding, Poverty alleviation and Social equity

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Background

The Conversion of Cropland to Forest Program (CCFP), also known as the Sloping Land Conversion Program (SLCP) or 'Grain for Green', was initiated in a context of ecological crisis and rising environmental awareness in China [1]. In 1997 there was a severe 267 day drought in the Yellow River basin [2], followed in 1998 by massive floods that devastated both the Yangtze and Songhua River basins, resulting in 3,600 deaths, 13.2 million people left homeless, and widespread economic impacts [3,4].

In addition to the extraordinary weather conditions occurring between 1997–98 caused by ENSO (El Niño Southern Oscillation) [3], these flooding events were associated with growing pressures from human activities [5,6], particularly the over-logging of natural forests and conversion of forests on steep slopes into farmland [7,8]. The authorities mainly attributed this disaster to unsustainable logging practices in State Forest Farms [7] and the conversion of forestland into cropland on steep slopes by smallholders throughout the catchments [4]. In response, the central government radically reoriented its forest policy by moving from a focus on timber production to a strategy involving conservation, restoration and livelihoods. A range of new programs related to forest conservation and environmental restoration followed, which together are known as the Priority Forestry Programs (or the Six Key National Forestry Programs). The first two of these programs to be introduced, and the most far-reaching, are the Natural Forest Protection Program[a] (NFPP) and the CCFP.

The NFPP was launched in 1998 to ban logging in the upper reaches of the Yangtze River and upper-middle reaches of the Yellow River, and the launch of the CCFP soon followed, with pilot sites introduced in the Yangtze and Yellow River basins in 1999. While the former program had the objective of reducing timber harvests, the latter aimed to restore vegetation on sloping croplands and lands classified as "wasteland" or "barren land" used by smallholder farmers [9].

The original intention of the CCFP was to reduce flooding and soil erosion; however the program was revised after a few years of operation to emphasize the improvement of rural livelihoods and poverty alleviation, in line with the emerging focus of the national poverty reduction strategy [10-12]. The CCFP can thus be conceptualized as an afforestation program or a large-scale forest Payment for Ecosystem Services (PES) scheme with a compensatory approach towards upstream areas inhabited by economically less-advantaged populations, who play a key role in providing downstream users with forest ecosystem services. The scheme represents an important monetary compensation from both central and local governments to these upstream smallholders.

Through a large-scale conversion of land use (from sloping cropland into forestland) and economic reorientation (from on-farm towards off-farm sectors) in upstream areas, the CCFP is designed to provide ecosystem goods and services, initially to upstream populations and in the long run to downstream populations.

Since the CCFP's inception, compensating smallholders for the opportunity cost of converting their sloping cropland into forest has been the core operational mechanism of the program. At the beginning of the program, compensations included a one-time payment for the purchase of saplings or seeds, an annual living allowance paid per unit area of cropland enrolled, and an annual grain/cash subsidy (with different amounts for households in the Yangtze River watershed and the Yellow River watershed regions[b]) [9,13]. The payment period of this three-tiered compensation system also depends on the type of land-use to be established, with two years of payments provided for converting cropland into grasslands[c], five years for converting cropland into forests of 'economic trees' (trees with direct economic returns) and eight years for converting cropland into forests of 'ecological trees' (trees with higher use restrictions). Program participants are paid conditionally upon maintaining a tree-survival rate higher than a minimum set at between 70% and 85%, depending on local criteria, which is verified by annual site inspections [13].

The nature of the CCFP's interventions has since evolved from this three-tiered subsidy system to its current simplified form, with a single cash payment now integrating the former grain compensation and livelihood-allowance subsidies, whereas seedling subsidies have been removed from the CCFP intervention. Apart from the compensation delivered to farmers, half of CCFP investment has been used on complementary activities such as cropland improvement, replanting on CCFP land, rural energy, etc. With regard to policy enforcement, the central government sets national-level compensation standards, while provincial governments may make further contributions for higher farmer compensations. The CCFP is implemented by county-level Forestry Bureaus, which were responsible for determining the sloping lands eligible for conversion and later allocating funds to those households willing to engage in the CCFP.

The CCFP is currently being implemented in 25 provinces (1,897 counties), has already afforested more than 25 million hectares (comprised of 9.27 million hectares of cropland and 15.8 million hectares of barren land classified as 'wasteland'), and provides direct subsidies to 32 million households (around 124 million people) [14,15]. In terms of its scale and magnitude, with 298 billion CNY (~42.82 billion USD) already invested between 1999–2013 [16], the CCFP is one of the most

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significant forest policies implemented in the developing world [9].

Objectives of the systematic review

After 15 years of implementation (1999–2014), it is timely to conduct a systematic evaluation of the program's impacts on both human populations and land resources. The objective of the systematic review is to provide evidence from the literature that could be used to actively inform the CCFP's design and future implementation, while identifying research gaps and new testable hypotheses so as to strengthen its positive impacts and minimize negative ones on both human populations and land resources. The systematic review will contribute by reviewing and analyzing not only the English-language CCFP literature, but also the data available within Chinese bibliographic databases. This systematic evaluation is also an important part of the Center for International Forestry Research (CIFOR)'s emerging Sloping Lands in Transition project (SLANT), which examines smallholder re/afforestation and sustainable forest management across several countries in the Asia-Pacific region.

Participants from CIFOR, China National Forestry Economics and Development Research Center (FEDRC) of the State Forestry Administration, Beijing Forestry University (BFU) and Forest Trends held together a stakeholder meeting in Kunming, China, in April 2014 to discuss research objectives and methods of this systematic review protocol (please refer to Additional file 1, list of participants). Special attention was given to defining the *populations* that might have been affected by the CCFP during its implementation period, and the actual *interventions* along with the potential *comparators* and *outcomes* of interest, a process that helped us to define our primary and secondary research questions. At the stakeholder meeting, we further compiled a list of contextual factors that might affect the implementation and outcomes of the CCFP, and discussed recurrent themes as found across a sample of articles.

Research questions

The primary research question of the systematic review is:

What socioeconomic and environmental effects has the Conversion of Cropland to Forest Program had on human populations and land resources during its first 15 years in China?

The secondary questions that the systematic review intends to find evidence for are as follows:

- How effective has the CCFP been in achieving its own stated objectives of soil erosion control, flood prevention and poverty reduction?

- Under which circumstances would/have farmers revert(ed) forestland back to cropland?
- Are there any unintended socioeconomic/ environmental outcomes?

Methods
Theory of change

A conceptual understanding of the CCFP using the methods of the theory of change can help to explain the cause-and-effect interactions between CCFP interventions and its expected socioeconomic and environmental outcomes (see Figure 1). The diagram below was designed after scoping the CCFP literature and following discussions with CCFP researchers and monitoring and evaluation specialists from the State Forestry Administration at the stakeholder meeting in Kunming, held in April 2014.

The first step in CCFP implementation began with the selection of households and sloping lands for participation in the program, which was undertaken by county-level forestry bureaus. Under the CCFP, smallholders are expected to become forest stewards on former agricultural and barren sloping lands. The institutional regulators are the central government which transfers economic resources to provincial governments which then, in turn, transfer the necessary funds to county-level forestry bureaus; these bureaus are responsible for CCFP implementation on the ground to provide smallholders with compensation for converting their cropland and barren sloping lands. On these agricultural and barren sloping lands, smallholders planted 'economic' or 'ecological' trees, a conversion that was actively facilitated through the delivery of a livelihood allowance, subsidies for purchasing tree saplings, and skill-training to plant the selected species.

After the conversion, it was expected that smallholders may experience an increase in available time (freed-up labor), which they could use to either intensify agricultural production on their lands or pursue off-farm work in urban areas; options that will be mediated by the degree of social equity among households and individuals in the CCFP implementation area (related to both intra-household and inter-household power relations across age, education level, gender, income and ethnicity heterogeneity factors). These options are expected to increase household incomes, which are further supplemented by compensation for any lost agricultural income from land conversion (paid following field checks by the county-level forestry bureau). The CCFP thus aims for livelihood change through reduced dependence on sloping agricultural lands, which will ultimately lead to a generalized poverty reduction provided that social equity and ecosystem functions are actively promoted [17]. In the medium term, the delivery of
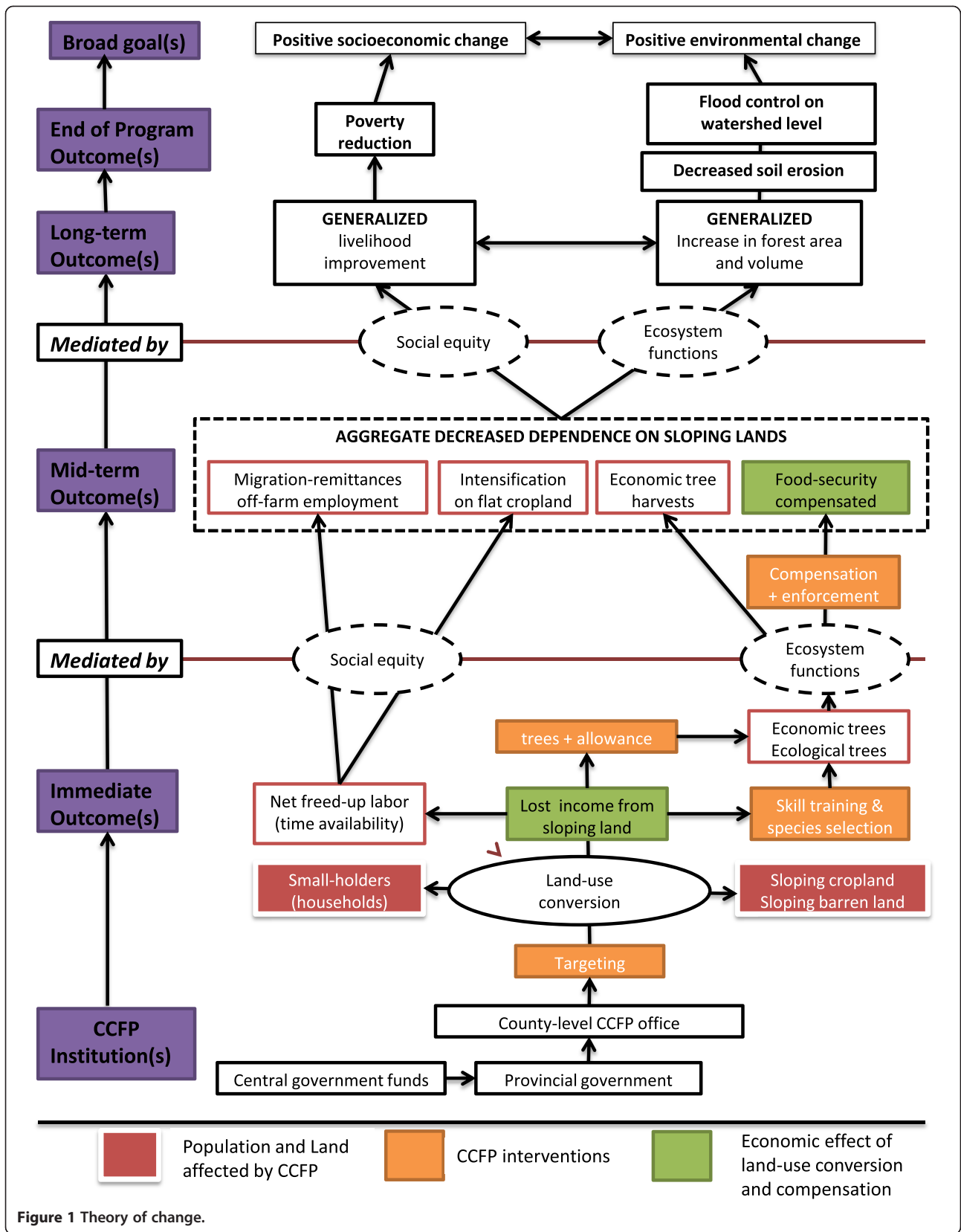
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Figure 1 Theory of change.

these annual subsidies will compensate smallholders for the opportunity cost of such livelihood changes.

In terms of environmental outcomes, the core assumption of the CCFP is that increased forest area and timber volume on sloping lands will lead to a decrease in erosion and thereby a decrease in flood risk at the watershed level. Thus the higher subsidies paid for planting 'ecological' trees rather than 'economic' trees should lead to a greater incentive for reforestation on longer timescales. Nonetheless, both types of planted forest will contribute to the reduction of soil erosion on sloping lands. Moreover, skills training and monitoring provided by county forestry bureaus are expected to lead to higher tree survival rates, as will the selection of suitable tree species for individual sites. The targeting of suitable households and the degree of farmer voluntarism in participating in the CCFP will also affect the longevity of land conversion and thus the achievement of its broader environmental goals. It is expected that farmers who have sufficient livelihood alternatives to agriculture (ie. availability of non-targeted farmland or sources of off-farm income) and willingly choose to participate will be less likely to reconvert lands back to agriculture after subsidies end. On the other hand, if disadvantaged farmers and groups are not effectively targeted [17], this could also be a deterrent for achieving both the environmental and socioeconomic goals of the program, i.e. to produce a generalized socio-ecological readjustment towards soil conservation, flood prevention and poverty reduction. Finally, the targeting of suitable lands is critical for the success of the CCFP, as sloping lands that have already experienced considerable degradation may be difficult to rehabilitate through tree planting alone, and suitable sloping lands may not always be targeted if they are difficult to reach (and thus monitor).

On the basis of the CCFP's theory of change we are going to evaluate the typology, methods, geographical coverage (systematic map), and the extent of the socio-economic and environmental effects brought about by the program during its first 15 years of implementation (systematic review). Subsequently, within the systematic review, we will evaluate the effectiveness of the CCFP in achieving both its socioeconomic and environmental objectives, as defined by soil erosion control, flood prevention and poverty reduction. Moreover, we will also assess the range of both intended and unintended outcomes, including studies that find forest reconversion to cropland and account for its explanatory factors.

PICO framework

To operationalize our research questions, theoretical hypotheses and database searches, we have further defined a Population-Intervention-Comparator-Outcome (PICO) model (see Table 1).

Populations

Our target human population consists of CCFP participant households and their individual members. Our target land resources population consists of CCFP enrolled lands (cropland, wasteland, ecological trees, economic trees).

Interventions

As the CCFP is enacted through multiple activities, interventions of interest consist of CCFP subsidies paid to smallholders for land converted, skill-training for local farmers, and enforcement of CCFP implementation (field-based checks on compensation delivery and household compliance with tree-survival rates).

Comparators

These are defined as both human populations and land resources that have not been exposed to the CCFP intervention (i.e. non-participant households and non-enrolled lands), with whom/which human populations/land resources exposed to the CCFP intervention might be potentially compared. Both households and lands prior to receiving CCFP interventions can also be compared to human populations/land resources post-CCFP intervention. Other types of comparators might also include macro-level comparisons between upstream interventions and upstream non-interventions or upstream socio-ecosystems prior to and following the CCFP intervention, and also comparisons between upstream and downstream socio-ecosystems. All these comparators will be used for analysis whenever there are available studies that can provide these primary data (i.e. on the actual socioeconomic and environmental effects of the CCFP).

Table 1 PICO elements of the systematic review

Population(s)	Intervention(s)	Comparator(s)	Outcome(s)
CCFP households and their individual members	CCFP (subsidies , skill-training, and enforcement with field checks	Non-participant households, households prior to CCFP implementation	Socioeconomic outcomes (changes in households' income structure, migration, etc.)
CCFP enrolled lands (cropland/ wasteland/ecological trees/ economic trees)	CCFP (subsidies , skill-training, and enforcement with field checks	Non-enrolled sloping lands, lands prior to CCFP implementation	Environmental outcomes (changes in water discharge, soil erosion, flood risk, local biodiversity, etc.)

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Outcomes

Socioeconomic outcomes of the CCFP include impacts on household production (income, labor allocation, employment), household consumption, land tenure, food security and nutrition, social equity, farmers' autonomy in decision-making, power relations (including between income groups, ethnic groups, gender), and rural out-migration and remittances.

Environmental outcomes include impacts on watersheds (floods, discharge rates, filtration), soil (erosion, nutrients), changes in forest cover and standing volume, tree-survival rate, changes in tree biomass and carbon storage, changes in biodiversity, changes in energy sources (biomass, coal, hydro, solar), and other land-use and cover changes (LUCC).

Other socioeconomic and environmental outcomes reported in the literature will be noted. These potential interactions and hypotheses have been explained in detail within the 'theory of change' section and, whenever there are available studies, socioeconomic-environmental interactions will also be reported.

Search strategy

Our search strategy has been structured according to the Collaboration for Environmental Evidence's guidelines [18] and a PICO framework to consider the CCFP's impacts on both human populations and land resources.

Searches

During our initial literature scoping, we assessed the breadth of the CCFP's current bibliography and determined that Chinese research databases contain an enormous body of potentially relevant literature. Around 500,000 hits were initially identified within the Chinese China National Knowledge Infrastructure (CNKI) databases when employing the phrase 退耕还林 (CCFP) as a search term. This huge number would later be reduced to about 3,500 hits by making use of *population*, *intervention* plus *comparator* and *outcome* search terms within the frame of our research strategy.

Languages: Searches will be conducted in English and Chinese. Spanish was also used in our scoping search searches, but as there were no meaningful results (no published literature), Spanish has been removed from the final search strategy.

Time frame: Searching will be limited to studies published or produced in and after 1999, the first year of CCFP implementation

Search terms: See Table 2 below for a comprehensive list of search terms as organized by their Population, Intervention, Comparator, and Outcome categories.

Search strings and/or combinations of searches Search terms from each of the population, intervention, comparator and outcome categories were combined using the Boolean command OR, then combined in a comprehensive search string using the Boolean command AND. Our searches will be adjusted for the specific requirements/features of each database and their specific truncation and/or wildcard symbols. For instance, as Google Scholar does not allow the use of complex search strings, the following intervention terms will be used: Conversion of Cropland to Forest Program (CCFP), Sloping Land Conversion Program (SLCP), Grain for Green, Upland Conversion Program, China. The Chinese search strategy was reviewed by a subject specialist librarian at the University of Michigan (see Additional file 2, for a detailed account of the search strings that have been employed in this protocol).

Estimating the comprehensiveness of the searches
Our scoping searches confirmed our previous expectations that Chinese databases would retrieve a far higher number of results than English databases, and that this difference is striking in quantitative terms. Initial search results showed Chinese results to be over a thousand orders of magnitude greater than English results. After refining our search strings, around 900 results were identified from English databases (486 hits in Web of Science, 253 hits in Scopus, 144 hits in CAB abstracts and 21 hits in AGRIS, or 879 unique hits after duplicate removal) compared to around 3,500 hits (titles) from Chinese databases.

Publication databases We aim to identify CCFP peer-reviewed articles, CCFP doctoral theses and CCFP master theses, and other study types through the following sources:

- Web of Science, Scopus, CAB Abstracts, AGRIS (FAO).
- CNKI or 中国知网, which includes China Academic Journals Full-text Database, China Doctoral Dissertations Full-text Database, China Masters' Theses Full-text Database, China Core Newspapers Full-text Database, China Proceedings of Conference Full-text Database.

Internet searches We will use Google Scholar to conduct internet searches. In developing these methods, the first 200 studies listed were retrieved for screening as a test of the search strategy. The comprehensiveness of the databases versus the internet as a source of articles determined to be relevant through screening will be reported in the review.

Specialist searching for grey literature, contacts and organizations: During the searching process we will

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Table 2 PICO search terms

Population search terms	English	Chinese
Human population	household, farmer, family peasant	农户, 农民
Land resources	sloping land, cropland, wasteland, economic forest/tree, ecological forest/tree, land use, soil water, basin	坡地, 耕地, 荒地, 经济林, 生态林, 土地使用, 土壤, 水, 流域
Intervention search terms	**English**	**Chinese**
	Conversion of Cropland to Forest, Sloping Land Conversion Grain for Green Upland Conversion	退耕还林
Comparator search terms	**English**	**Chinese**
Human comparators	Participant, non-participant intra-household, upstream user downstream user, uphill resident, lowland resident cross-sectional, comparison comparative, longitudinal space, time, panel data	参与者, 非参与者, 家庭成员/农户成员, 上游使用者, 下游使用者, 山地居民, 低地(平原)居民 横截面(数据), 比较, 纵向(数据), 空间, 时间, 面板数据
Land resources comparators	Enrolled, non-enrolled upstream, downstream uphill, lowland cross-sectional, comparison comparative, longitudinal time series, space, time panel data.	退耕地, 未退耕地, 上游, 下游, 山地, 低地(平原), 横截面(数据), 比较, 纵向(数据), 空间, 时间, 面板数据
Outcome search terms	**English**	**Chinese**
Socioeconomic outcomes	household production household consumption food security, nutrition livelihood equity, power relations, equality, Gini, gender, intra-household, ethnic decision making, governance voluntary migration, remittances.	农户生产/家庭生产, 农户消费/家庭消费, 粮食安全/粮食保障, 营养 民生/生计, 公平, 权力关系, 平等, 基尼系数, 性别平等, 家庭内关系, 少数民族, 政府决策, 治理, 自愿程度/志愿程度, 迁移, 汇款.
Environmental outcomes	watershed, floods, discharge rate, soil, filtration, erosion, soil nutrient deforestation, forest degradation, afforestation, reforestation forest cover, survival rate biodiversity, biomass, carbon energy, land use and land use change	流域, 洪灾/水灾/洪水灾难, 流量, 土壤, 土壤渗滤, 水土流失/土壤流失/土壤侵蚀, 土壤养分, 森林砍伐/毁林, 滥砍滥伐, 森林退化, 造林, 再造林, 森林覆盖率, 林木成活率/林木保存率, 生物多样性, 生物量, 碳汇量, 能源, 土地利用和, 土地利用变化

identify key institutions/organizations that could potentially be involved in conducting research studies linked to the CCFP. Afterwards, we will search for additional reports delivered by these institutions/organizations' websites. Moreover, we have also issued a call for grey literature, with both English and Chinese language brochures being circulated online and hard copies distributed at relevant meetings and conferences [19]. In the meantime, an advisory group formed by the people who took part in the stakeholder meeting in Kunming will also provide key inputs in recommending relevant reports/datasets that may be unpublished or not found in our searching.

Inclusion criteria

Relevant subjects: Both human populations and land resources are to be included as relevant populations, including: CCFP participant households, their individual members and their CCFP enrolled lands (cropland, wasteland, ecological trees, economic trees). Grasslands are excluded from our analysis since they no longer form part of the CCFP, they are under the administration of the Ministry of Agriculture, and because they contribute to significantly different environmental outcomes as compared with forests.

Relevant interventions: These include CCFP compensation subsidies, skill training for local farmers, and enforcement work with field checks. When possible, we will retrieve all information on other types of subsidies that might have an impact on household livelihoods and the environment. Broadly speaking, the Natural Forest Protection Program (NFPP) does not overlap with the CCFP, as the former is related to state forestland whereas the latter mainly occurs over collective forestland. Therefore, the NFPP is not included in our analysis (although it is taken into account as a contextual factor).

Relevant comparators: We are interested in assessing the existing evidence comparing the effects of the CCFP between *participating and non-participating* CCFP households. This systematic review will simultaneously consider the available evidence about CCFP land resources' comparators such as both *enrolled and non-enrolled* lands (under the management by both types of households dwelling upstream). This systematic review will also use the available empirical data to track those 'before-and-after' comparators in both human populations (i.e. the socioeconomic status of both participant and non-participant households *before and after* the CCFP interventions) and land resources (i.e. the environmental status of both enrolled and non-enrolled lands before and after

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the CCFP intervention). At a more aggregated level, we will synthetize the available evidence on the effects of the CCFP on watershed with-intervention upstream and without-intervention upstream socio-ecosystems (i.e. both between intervention and non-intervention watershed regions, and between pre-CCFP and post-CCFP watershed regions), and also between upstream and downstream socio-ecosystems.

Relevant outcomes: From the stakeholder workshop and initial literature scoping, we have identified a number of relevant socioeconomic outcomes; including CCFP impacts on: household production and consumption; changes in household land tenure; changes in food security and nutrition; social equity (between and within households), farmers' autonomy in decision-making, power relations (income groups, intra-household and gender levels, ethnic groups); migration and remittances. With regards to environmental outcomes of interest, we have identified the following: floods and watershed discharge rates; soil filtration, erosion and nutrient cycling; deforestation and forest degradation on slopes (should farmers revert converted land back to cropland); forest cover, afforestation and reforestation; tree-survival rates, biodiversity, biomass and carbon storage; changes in household energy sources (biomass, coal, hydro, solar, etc.); and land-use cover change (LUCC) dynamics. Studies assessing potential or future outcomes of CCFP, including model projections or other predictions of program impact, will not be included as this review only seeks to assess the actual impacts of CCFP implementation (those which have already taken place). Socioeconomic-environmental interactions will be reported, whenever there are available studies on this issue.

Relevant types of study design: Primary studies using quantitative and qualitative methods will be considered; these can include experimental and quasi-experimental designs, case–control experiments and broad sample-size surveys of participant and non-participant populations (cross-sectional analyses), surveys of populations prior to and following CCFP implementation (longitudinal analyses), and individual case studies of populations that have been targeted for CCFP interventions. Studies must use primary data to present actual impacts that have already happened, and are causally linked or correlated to the CCFP interventions. Primary studies concerning farmers' perceptions of CCFP impacts will also be included, provided that a robust and reliable methodology was used, as these perceptions can be used as a proxy for measuring certain socioeconomic impacts. Modeling exercises that use primary data to calculate actual impacts shall be included for further analysis, whereas models that project potential or future impacts will not be included (although they will be collected in a separate folder for future analysis).

With regards to qualitative evidence, we will consider the following design/methods: participant and non-participant observations, structured, semi-structured, and unstructured interviews, focus group discussions, and qualitative data from surveys and questionnaires. On the other hand, with regard to quantitative evidence, we will consider the following design/methods: direct measurements of observed phenomena, including use of geo-spatial technologies (GIS and remote sensing) as well as the use of polls, questionnaires, and surveys where answers are restricted to given choices. Finally, studies that will not be considered for data extraction include reviews, meta-analyses, summary studies, theoretical and methodological framework studies, and editorials and commentaries, although these will be considered in our background and discussion.

Study screening Given the big volume of references expected from the Chinese literature database, we will first perform title screening, then abstract screening, and finally full-text screening of retrieved search results according to the inclusion criteria stated above. For the English literature database, we will first conduct title-and-abstract screening and later full-text screening. At the beginning of each stage of screening, four reviewers for English (NH, WZ, LP and LGR) and three reviewers for Chinese (CX, KZ and LGR) will review a sample of 50 studies to conduct kappa analysis on their screening decisions. Should the kappa statistic fall below 0.6, the reviewers will discuss points of disagreement and conduct a second round of screening. This will take place for both the Chinese and English language literature, with LGR coordinating pilot screening in both languages. Once an acceptable level of agreement is reached, the remainder of studies will be screened in each stage. Members of the advisory group will also randomly review the screening, and for a 25% selection of the scoped files, tests will be conducted first on the abstracts and then on the full-texts to ensure screening decisions remain consistent. Then full-text reading and extraction of qualitative and quantitative information will proceed into several categories (see next subsection, study quality assessment).

Potential effect modifiers and reasons for heterogeneity

During the stakeholder workshop in Kunming (April 2014), a set of independent socioeconomic variables with potential influence on CCFP outcomes was defined, including: household members' age, gender, education level, income group and ethnicity. These variables will be useful to assess cross-household and intra-household heterogeneity of CCFP impacts. For instance, we can assess if impacts of the CCFP equally affect households with different income levels, or whether different members of the same household experience different socioeconomic impacts. At the same time, a set of independent environmental

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variables with potential effects on CCFP outcomes at the targeted land plots were also defined, including: orientation, slope, size, distance to home, weather/climate, altitude and latitude. Socioeconomic-environmental interactions among these factors can be especially relevant for the CCFP implementation process.

Study quality assessment (critical appraisal)

Those studies that meet our inclusion criteria through the full-text screening will be assessed based on the following five quality criteria:

1. Data collection methods are thoroughly explained and clear and replicable.
2. Qualitative or quantitative analysis methods are thoroughly explained and clear and replicable; key terms and variables are well defined.
3. Sample size is well explained and representative of the population.
4. Results/conclusions are logically derived and supported by presented evidence.
5. Confounding factors are considered and well explained.

We will document individual study quality based on each of these five criteria, and report on the overall quality of the evidence base in our systematic review. For each study, we will also record yes/no answers for each criteria, where "yes" is equal to a score of one and "no" equal to a score of zero. Each study will thus have a quality assessment score of 0 to 5, where scores of 3 to 5 will be considered acceptable while studies with scores of 0 to 2 will be considered low quality. For our systematic review, we will consider and compare the outcomes from both sets of studies to determine whether the low quality studies demonstrate significantly different results from those of acceptable quality studies, and whether their inclusion in our final analysis leads to any change in our overall assessment. Assessment of the studies against these criteria is a strong indicator of the presence or absence of most types of potential bias. In addition, we will check for patterns of correspondence between authors' affiliations and specific findings so as to identify additional sources of potential bias. We will also determine whether there are discernable biases in results that correspond to the study designs used (i.e. control/counterfactual, longitudinal study, or case study).

Data extraction strategy

For all studies that have met our critical appraisal criteria after full-text screening, we will proceed with extracting both quantitative and qualitative data for both socioeconomic and environmental outcomes, following the general structure of our PICO framework and using the set of factors of interest that were raised in discussions at the stakeholder meeting in Kunming. The data extraction categories are as follows:

Study metadata and methodology:

- Bibliographic information: author, year, title, institution of the lead author.
- Type of study: quantitative/qualitative study, or both (mixed methods).
- Comparative methods: cross-sectional, longitudinal, or both.
- Geographic location (county and GPS coordinates whenever available)
- Time-span covered by the study.

Population:

- Type of population: human population, land resources population, or both.
- Unit of comparative analysis (scale): household/individual, village/community, county, provincial or national levels.
- Sample size and land area: number of households covered by study or land area covered by the study.

Intervention:

- Type and duration of intervention: compensation subsidies plus tree-sapling provision, skill-training, enforcement with field checks (one or multiple intervention types can be present).

Outcomes:

- Socioeconomic outcome categories: changes in upstream household production and production structure (as measured by income, labor, employment); changes in household consumption and household income structure; changes in household land tenure; changes in social equality (Gini coefficient) and intra-household equality, both of them across income levels, gender, age groups and educational levels; changes in household migration and remittances; enforcement (voluntary/compulsory and degree of tree species selection).
- Environmental outcome categories: changes in upstream forest cover and standing volume, tree survival rates, changes in measures of biodiversity (species richness, composition, and abundance), tree biomass and carbon storage; changes in upstream soil erosion and soil nutrient content; changes in upstream household energy use and energy structure; changes in upstream land-use and

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land-cover change (NDVI and leaf-area indices); changes in downstream discharge rates and floods; frequency of natural disasters; trade-offs among ecosystem services.

- Socioeconomic-environmental interactions (among the aforementioned outcomes), whenever there are available studies on this issue.

Potential effect modifiers and reasons for heterogeneity:

Socioeconomic factors: household members' age, gender, education, income group and ethnicity:

– Age: average and percentage distribution across several ranges (over 20, between 20–40, between 40–60, and over 60).
– Gender: percentage of women/men
– Education: average and percentage distribution across several ranges (primary school or less, middle school, high school or above).
– Income group: locally-defined low, middle and high income groups.
– Ethnicity: Han/non-Han
– Environmental factors: land orientation, slope, size, distance to home, and elevation of land plots
– Other: Voluntarism of participation in CCFP

Data synthesis and presentation

One narrative synthesis report, i.e. a systematic review, will be produced relying on both qualitative and descriptive statistics so as to assess the available evidence on the CCFP's socioeconomic and environmental outcomes. Using descriptive statistics, we will first present the results of each screening stage (title, abstract, and full text screening) and will also use statistics to show the results of the quality assessment (high quality vs. low quality studies). Secondly, we will organize and synthesize the data according to the types of research conducted on the Conversion of Cropland to Forest Program, through: 1) categorizing the empirical evidence as socioeconomic and/or environmental; 2) classifying its research methods in typologies; and 3) presenting the geographical distribution of studies throughout the country. Qualitative data on both socioeconomic and environmental outcomes will be grouped by the individual measures they address (i.e. income change, forest cover change, etc.) and synthesized narratively alongside quantitative data on the same measures. In so far as we have sufficient data to perform meta-analysis of quantitative data of outcome measures (and particularly their correlation with human and environmental population characteristics), we will do so.

With regard to the main research question, the socioeconomic and environmental outcomes of the CCFP will be also presented in a searchable database, provided along with a geographic map that identifies and locates the available evidence from studies across China. GIS and Remote Sensing techniques will be used to document the locations of included studies within China to compare the coverage of CCFP evaluations with the actual area of its implementation.

As for the secondary research questions, the existing results on the program's effectiveness will be first synthesized and accordingly presented in terms of its achievements in poverty reduction, soil erosion control and flood prevention. Second, conclusions will be made in terms of conditions that may have led to the reconversion of sloping lands to agriculture. Third, CCFP's unintended socioeconomic and environmental effects will be synthesized and presented in order to guide future program implementation and research, and also to uncover possible knowledge gaps and new hypotheses on the program's impacts.

Endnotes

[a]The NFPP was approved in 1998 so as to stop natural forest loss and degradation [15]. The introduction of this 'logging ban' policy meant the re-structuring of state-owned forestry enterprises, into which government subsidies have been channeled to compensate laid-off workers and alleviate the economic crisis faced by these companies in the late 1990s.

[b]Since 2004, grain transfers were completely replaced by cash.

[c]Although the CCFP initially included the conversion of cropland into grassland, this land-use transformation no longer forms part of the program, and so has become a different program which is currently under the Ministry of Agriculture.

Additional files

> **Additional file 1: Participants in stakeholder meeting, Kunming, April 2015.**
>
> **Additional file 2: Search String Combinations.**

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