AMAZALERT Delivery Report

Title	Priority ecosystem services and initial scenarios
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To complete by the Coordinator

Approved by the Coordinator	YES
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Background

AMAZALERT project (*Raising the alert about critical feedbacks between climate and land use change in Amazonia*) is a consortium of Scientists from 14 renowned European and South-American research institutes to forecast what may happen to the Amazon over the coming decades by studying climate, vegetation, land use change and water availability relationship in over 3 years' (2011-2014). Some reports have suggested that under continued climate change and deforestation the forests of the Amazon may be vulnerable to some form of die-back. The aim of AMAZALERT is to test how likely this prediction is, and if so, to forecast where in the region, when and how this may happen. The Project is organized in seven working packages (wp1-wp7). In Bolivia the project is implemented by the Fundación Amigos de la Naturaleza (hereafter FAN) which is in charge of supporting the identification of priority Amazon ecosystem functions and services and their drivers of change (wp1) between other responsibilities.

The project held an inaugural meeting from 3-5th October, at the premises of the Centre for Earth System Science of, INPE, in São José dos Campos (SP-Brazil). The first two days of the Kick-off meeting the consortium worked together. The third day of the meeting was the stakeholders workshop to identify and prioritize the most important large-scale Amazonian ecosystem services and drivers of change. In the morning presentations were held and in the afternoon all the participants formed groups and filled out a questionnaire. The original idea was that there would be 10-15 stakeholders, but there were only 3, however the workshop was carried out anyway to get the perception of the AMAZALERT team and its stakeholders suggestions for future connections.

Objectives

- To identify priority Amazon ecosystem services and their drivers of change.
- To explore the potential critical limits of these ecosystem services and link with models
- To design a set of initial socio-economic scenarios to drive the AMAZALERT models

Methods

STAKEHOLDERS WORKSHOP ORGANIZATION

Since July of 2011 the project members had been coordinating the kick-off meeting (3-5th October of 2011) by email. The stakeholders meeting (only October 5th) was organized by wp1 members. Consequently, wp1 and wp4 members had a conference call (September 6th) to coordinate the stakeholders attendance, the tentative agenda for the workshop and the questionnaire. The conference call participants were:

- **Alterra / WUR (Wageningen University):** Bart Kruijt and Kasper Kok.
- **Joanneum Research:** Naomi Peña
- **EMBRAPA (Empresa Brasileira de Pesquisa Agropecuaria Brazil, Brazilian Agricultural Research Corporation):** Mateus Batistella and Claudio Bragantini.
- **INPE (National Institute for Space Research):** Ana Paula Aguiar, Celso von Randow and Luciana Soler.
- **FAN:** Graciela Tejada Pinell.
- **PIK (Potsdam Institute for Climate Impact Research):** Kirsten Thonicke.
- **University Gent (Belgium):** Hans Verbeeck.

In the next days, the work continued in base of a working draft document prepared by FAN and PIK, were the final agenda was consented (ANNEX 1). Besides that, the work on the priority ecosystem services questionnaire continued, in the first place EMBRAPA sent a tentative list of ecosystem services relevant for the Amazon based on de Groot et al.

(2002)[1]. Then FAN made a similar list considering the functions and ecosystem services and its main drivers of change. Finally to coordinate the final ecosystem services list for the questionnaire a Skype meeting between Kirsten Thonicke (PIK), Celso von Randow (INPE) and Graciela Tejada (FAN) was made on September 28th of 2011. After this the first version of the questionnaire was ready.

DURING THE WORKSHOP

- *WP1 AND WP6 MEETING ON THE FIRST DAY OF THE KICK-OFF MEETING.* The first day of the kick-off meeting in the afternoon a wp1 and wp6 meeting was held. In this meeting, the first version of the questionnaire was discussed getting an adjusted version. The main modifications were to include the ecosystem functions in the list and group the ecosystem services in bigger groups. The participants of the meeting considered that the second part of the questionnaire (drivers of change) was too long.

- *MORNING PRESENTATIONS ON THE STAKEHOLDERS WORKSHOP (THIRD DAY OF THE KICK-OFF MEETING).* All the presentations carried out according to the final agenda were very interesting and made a nice introduction to the project and the working groups of the afternoon. There was an additional presentation about the Scenarios Program in the Amazon exposed by Paulo Brando from the Amazon Environmental Research Institute (Instituto de Pesquisa Ambiental da Amazônia, IPAM).

- *FILLING OUT THE QUESTIONNAIRE ABOUT PRIORITY ECOSYSTEM SERVICES IN THE AMAZON.* In the afternoon of the stakeholders workshop (October 5th), all the participants were split in tree groups. Assistants to the wp1 and wp6 meeting were the leaders of each group: GROUP 1, Naomi Pena; GROUP 2, Ronald Flipphi, and GROUP 3, Kirsten Thonicke. Each participant filled out the questionnaire (ANNEX 1) alone and then the entire group filled out one questionnaire generating discussion and consensus about the main ecosystem services in the Amazon and its main drivers of change. At the end of the afternoon, each group leader discussed their experiences and comments. The common observations were: 1) the questionnaire is too long (most of all the second part about the drivers of change), and 2) the filling out of the table has to be fast (without thinking too much) and considering only the ecosystems services directly related to the stakeholders (explain this to them).

AFTER THE WORKSHOP

QUESTIONNAIRE SENT TO THE BOLIVIAN STAKEHOLDERS, RAISG[2] NETWORK AND NATIONAL UNIVERSITY OF COLOMBIA (UNAL) SUGGESTIONS.

After the stakeholders workshop all the results were systematize. Also considering all the observations and suggestions of the AMAZALERT members a third version of the questionnaire (ANNEX 2) was made. This version was sent to the Bolivian stakeholders (also the Peruvian stakeholders suggested during the stakeholders workshop). Consequently a fourth version of the questionnaire (ANNEX 3) was made considering some suggestions by JR, the RAISG and UNAL network got this version.

[1] De Groot RS, Wilson MA, Boumans RMJ (2002) A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics, **41**, 393-408.

[2] Amazon Network of Socio-Environmental Geo-Referenced Information (RAISG, http://raisg.socioambiental.org)

Results and discussion

Stakeholders workshop (third day of the kick-off meeting)

AMAZON ECOSYSTEM SERVICES PRIORITIZED IN THE AMAZON

Workshop results of the stakeholders workshop are shown in TABLE 1. Twenty persons completed the questionnaire. In FIGURE 1 seven ecosystems were services selected as the most relevant in the prioritization: *consumptive use*, *carbon storage in intact forests and soils*, *maintenance of favourable climate*, *subsistence agriculture*, *fishing*, *providing living space to wild plants and animals*, and *protection of biodiversity*. Between these, *protection of biodiversity* is the service with the highest value (17 times) been the most important service for the AMAZALERT consortium. In the case of ecosystem services of information and habitat, *protection of biodiversity* is the service chosen as high priority by the participants, followed by *providing living space to wild plants and animals* that is strongly related. Most of the project members had a lot of experience in conservation, but in the modelling stages biodiversity modelling is not considered although vegetation, climate and water are considered. Finally in the regulation services *carbon storage in intact forests and soils* and *maintenance of favourable climate* are considered as high priority. These ecosystem services are well known for the project partners considering that they are in the research area and they know the benefits for the climate regulation. On the other hand, if the questionnaire would have been filled by local stakeholders, maybe they would not have identified the *carbon storage* and the *maintenance of favourable climate* as high priority due to the fact that their local reality and needs are more urgent (e.g. eat, fuel, water, etc.).

TABLE 1 Results of the Amazon ecosystem services prioritization. Each cell shows the number of times that each person weighted each ecosystem service. Not all the ecosystem services have the same number of selections, because in some cases some ecosystem services that were considered without relevance by participants were left blank. Ecosystem functions and services were chosen based on de Groot et al. (2002). The high-priority ecosystem services (cells with values ≥ 12 times) are marked with *.

Ecosystem functions	Ecosystem goods and services		Level of prioritization		
			High	Medium	Low
Regulation functions	Water cycle	Consumptive use	12*	4	4
		Natural floods	6	10	2
		Ground water	6	10	3
		Reduction of droughts	11	5	1
		Hydropower	2	12	3
		Transportation	10	8	2
	Soil	Erosion prevention	9	3	5
		Carbon storage	10	8	1
		Provision of nutrients	5	11	4
	Pest control		1	10	7
	Climate	Carbon sequestration	13*	6	1
		Maintenance of favorable climate	13*	6	1
		Reduction of extreme events	11	8	1
		Local climate	11	6	1
Production functions	Food	Cash crops agriculture	7	6	6
		Subsistence agriculture	13*	4	2
		Hunting/gathering	7	6	7

		Fishing	13*	4	3
		Feed	1	15	1
		Fiber	0	13	3
	Fuel	Firewood	2	6	10
		Agricultural waste	2	8	6
	Timber	Commercial	3	11	4
		Subsistence	3	13	3
Information		Recreation	4	9	4
		Inspiration	6	8	3
Habitat function		Providing living space to wild plants and animals	12*	5	2
		Protection of biodiversity	17*	2	0
		Collection of medical plants	7	8	4

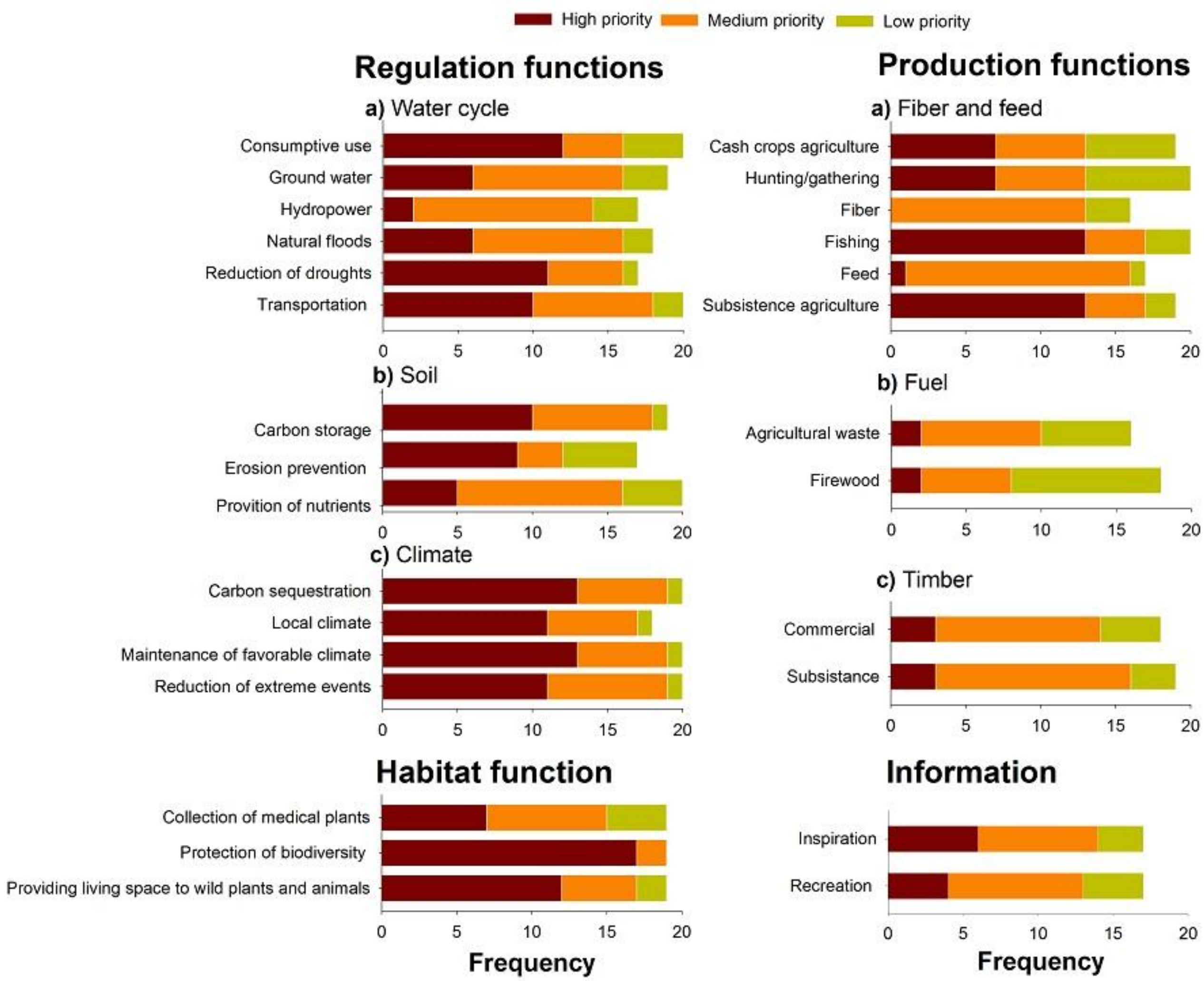

FIGURE 1 Amazon ecosystem services prioritization. The figure shows the results obtained to the prioritization of the regulation ecosystem services (**a**: water cycle, **b**: soil and **c**: climate), the production ecosystem services (**a**: fiber and feed, **b**: fuel, and **c**:

timber), and the prioritization of the information and habitat function ecosystem services. Frequency is referred to the number of times that each person weighted each ecosystem service.

MAIN DRIVERS OF CHANGE IDENTIFIED FOR THE KEY ECOSYSTEM SERVICES

The main drivers of change identified are shown in FIGURE 2a & 2b, and were only analysed for the seven ecosystem services identified as the most relevant (see TABLE 1). The drivers of change were split in two categories, deforestation (or land use change) drivers (FIGURE 2a) and climate-change drivers (FIGURE 2b). The key drivers of change identified that threaten the ecosystem services were *large scale agriculture production* and *infrastructure* (river dams, roads, settlements, expansion of cities, etc.), following by *slash and burn, wood industry (legal and illegal)* and *cattle ranching.*

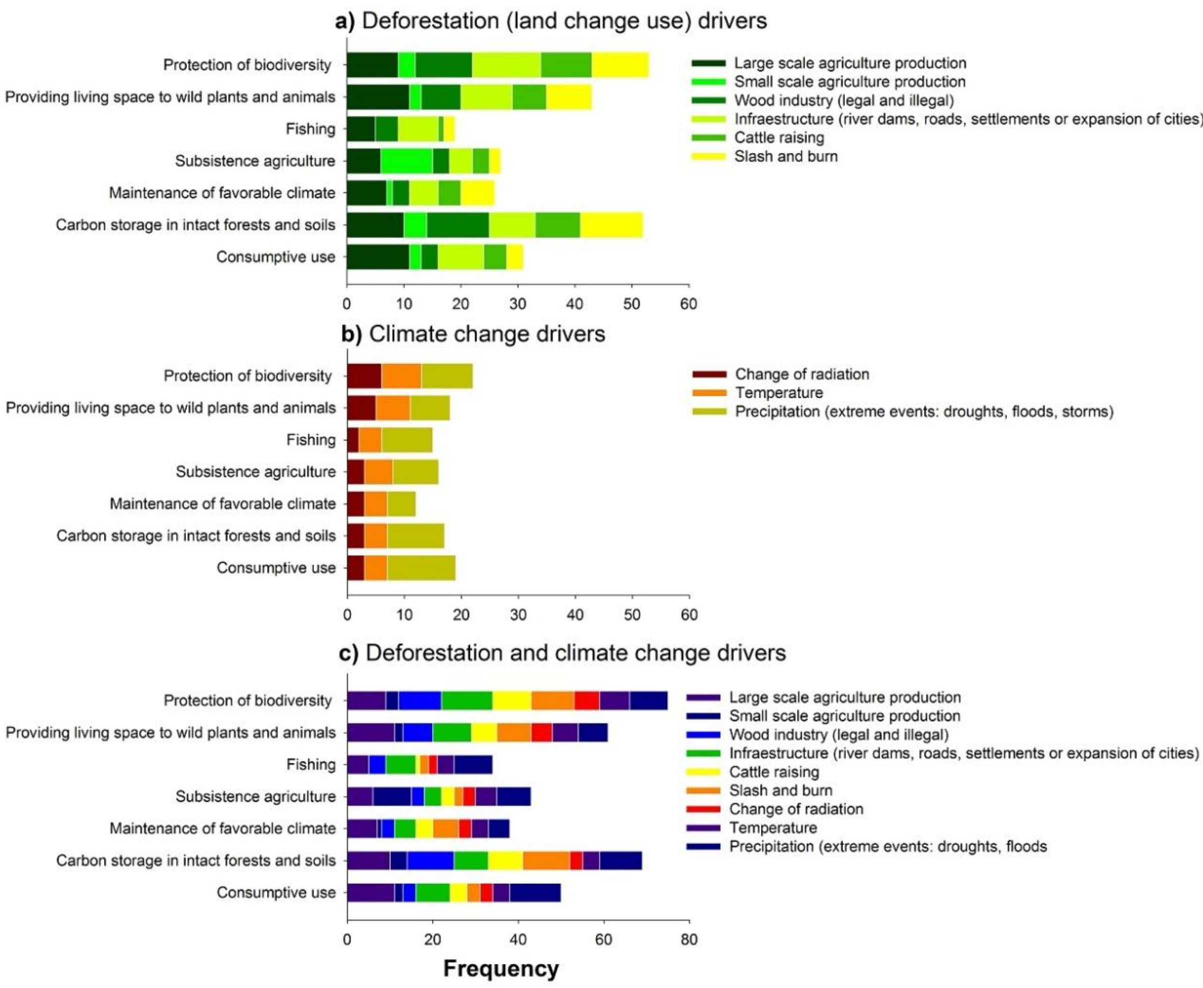

FIGURE 2 Amazon ecosystem services prioritization. The figure shows the results obtained to the prioritization of the regulation ecosystem services (**a**: water cycle, **b**: soil and **c**: climate), the production ecosystem services (**a**: fiber and feed, **b**: fuel, and **c**: timber), and the prioritization of the information and habitat function ecosystem services. Frequency is referred to the number of times that each person weighted each ecosystem service.

Assessment of vulnerability and critical limits of main ecosystem services – the link with models

While the critical ecosystem services, their drivers and critical limits have been assessed in the first workshop, involving mainly experts, the challenge is to also show from models and data that these critical limits exist. One of the few synthesis analyses on critical limits was presented by Nobre and Borma (2009), who showed that the Amazon is at risk for critical transitions at deforestation rates exceeding 40% and global temperature rise exceeding 3 degrees Celsius. It is one of the main objectives of AMAZALERT to advance on these assessments. Another challenge is, to make the connection between often specific and locally defined ecosystem services and the broad-scale, generalising output of global and regional simulation models. AMAZALERT has, instead of deriving critical limits from existing models at the outset, focussed on 1) new model runs and analysis (WP2, WP3) and 2) developing the necessary methodology to link ecosystem services as coming out of stakeholder assessments and model output. This is reported on in this section.

Current literature in the Amazon has focused on the analysis of ecosystem services that forests provide in order to point out the multiple negative effects the Amazon rainforest is exposed to, which not only arise from deforestation, but also from multiple activities such as logging or mining (Foley, Asner et al. 2007). The value of specific services such as provision of timber through analysis of forest statistics and valuation (Ahmed and Ewers 2012) and evaluation of freshwater-related services (Castello, McGrath et al. 2013) provide an important insight as well as a challenge to balance regulating, information and habitat functions with production functions needed to balance nature conservation with socioeconomic development in the region. First analyses, showing the disparity between land conversion for soybean and for other agricultural products versus losses of regulating and habitat functions and services, have been investigated by environmental economics, pointing out that even in economic terms deforestation for agricultural products does not balance economic gains from selling agricultural products (Mann, Kaufmann et al. 2012; Oliveira, Costa et al. 2013). These are valuable analyses, which focus on combining remote sensing products, statistics and sometime economic models, but how to analyse the changes in ecosystem services under future global change?

Including ecosystem or dynamic vegetation models in large-scale assessment studies of ecosystem services is relatively new (Tallis, Mooney et al. 2012), where remote sensing, national statistics and large-scale ecosystem models are to be combined in global monitoring systems. This new approach follows the ecosystem concept of de Groot et al. (2002), where ecosystem function becomes a service as soon as there is demand for it. This way, ecosystem models can quantify the provision of ecosystem services and by the comparison with socio-economic data, trade-offs can be identified. The concept also opens a new way of projecting ecosystem service supply (or provision of ecosystem services) into the future by considering climate and land-use change.

In the stakeholder workshops, experts have prioritized regulating, production and habitat-related ecosystem services the most. Considering that within AMAZALERT a number of dynamic vegetation models (in WP2) and 2 coupled vegetation-climate models (WP3) are working on simulating future changes in vegetation and climate, we have the opportunity to quantify a subset of ecosystem functions (see Table 2). This shows that a large set of services that were given high priority by the experts can actually be quantified using models. Out of the high-priority services only fishing and subsistence agriculture cannot be quantified by the models. Here, indirect measures could be developed by linking the amount of discharge simulated by the Dynamic Global Vegetation Models (DGVMs) and quantify an indicator if habitat for important fishing population is still provided. DGVMs with an agriculture component, such as the LPJmL model (Bondeau, Smith et al. 2007), can quantify the productivity and harvest of crops in the Amazon, however, whether this is rather commercial cash crop agriculture or subsistence farming can only be assessed in post-processing using additional information. There is, however, a high risk that this information is simply not available or too uncertain to include or compare in future simulations. By looking at all other services, it can be seen that this list opens a great opportunity to quantify future vulnerability of ecosystem services and potential trade-offs that may arise.

TABLE 2 Quantification of the provision of ecosystem goods and services using output from dynamic global vegetation models (DGVMs) and climate models (GCMs) in AMAZALERT through cooperation with WP2 and 3. Services that require further post-processing in order to quantify the service are marked with *, services that cannot be quantified by the models are left empty. Services that can be quantified by applying a DGVM with agriculture component are marked with [1]. Services that were prioritized the most are in bold.

Ecosystem functions	**Ecosystem goods and services**		**Model**	
			DGVM	**GCM**
Regulation functions	Water cycle	Consumptive use	**X***	
		Natural floods		
		Ground water		
		Reduction of droughts	**X**	**X**
		Hydropower	X*	
		Transportation	X*	
	Soil	Erosion prevention		
		Carbon storage	X	
		Provision of nutrients	X	
	Pest control			
	Climate	Carbon sequestration	**X**	
		Maintenance of favorable climate	**X**	**X**
		Reduction of extreme events	X	X
		Local climate		X
Production functions	Food	Cash crops agriculture	X*[1]	
		Subsistence agriculture	X*[1]	
		Hunting/gathering		
		Fishing		
	Feed		X[1]	
	Fiber			
	Fuel	Firewood		
		Agricultural waste		
	Timber	Commercial	X*	
		Subsistence	X*	
Information	Recreation		X*	
	Inspiration			
Habitat function	Providing living space to wild plants and animals		**X***	
	Protection of biodiversity		**X***	
	Collection of medical plants			

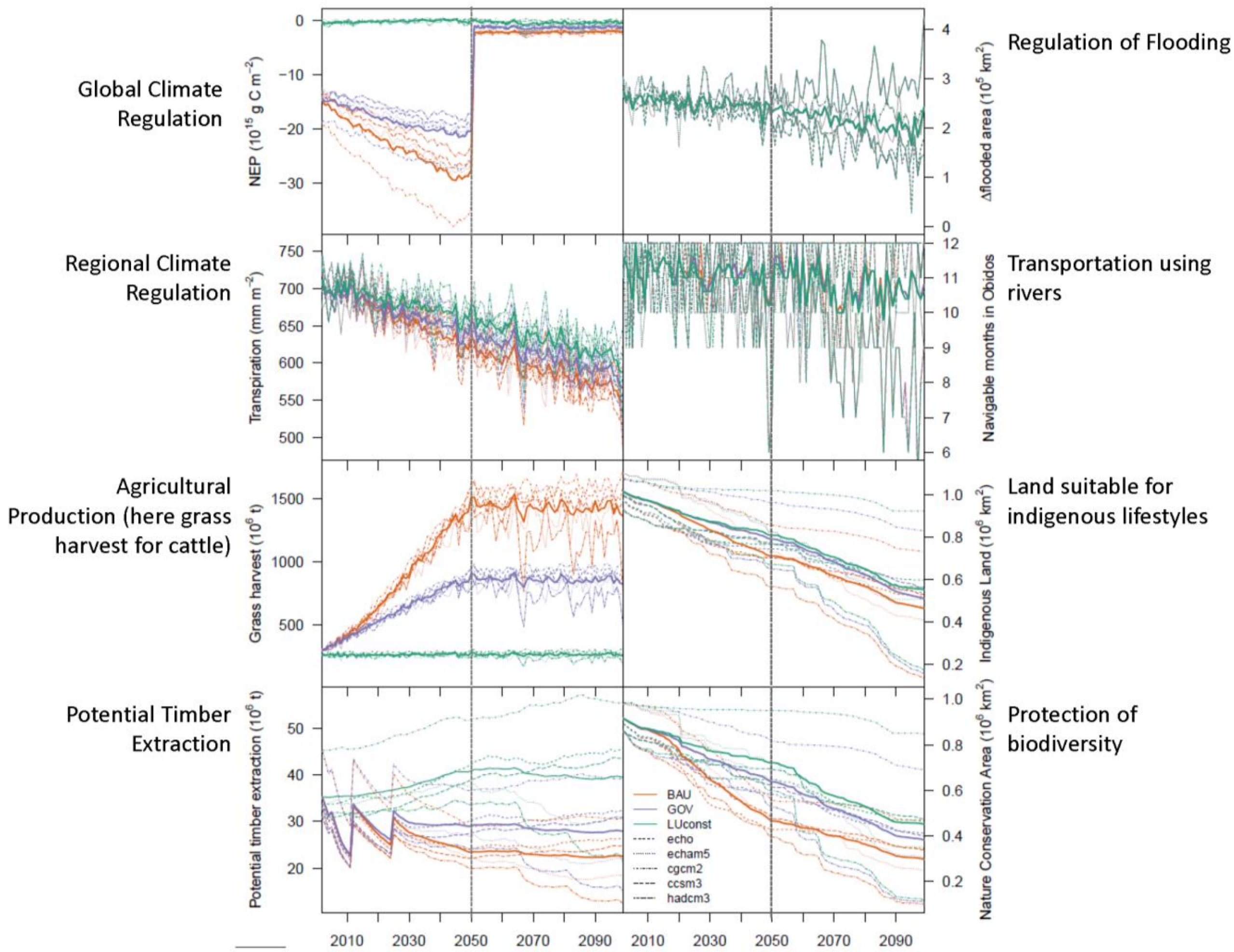

FIGURE 3 Amazon ecosystem services quantification. The figure shows the results obtained from the LPJmL DGVM to provide an example for quantifying global and regional climate regulation, maintenance of flooded areas for fish populations and riverine biodiversity, river transportation, agricultural production, potential timber extraction and protection of biodiversity under climate change (various climate simulations from the 4th assessment report and SIMAMAZONIA land-use scenarios). Source: Walz, Thonicke et al. (in prep).

We have worked on the quantification of a selected set of highly prioritized ecosystem services using output from the LPJmL DGVM. Figure 3 illustrates how ecosystem function and thus the provision of ecosystem services under future climate and land-use change can be affected. This first study shows that land-use change is decisive for maintenance of future ecosystem services and that there might be trade-offs between agricultural production and other services derived from productive ecosystem functions (Walz, Thonicke et al. in prep). We are also developing a scheme for combining output from the DGVMs describing the habitat integrity to combine them with maps of protected areas or indigenous land to estimate how these areas might be affected by climate and land-use change. This is an example of how these services can be quantified by further post-processing of model and other type of data. The next steps will be to use these concepts and apply them to output from other DGVMs in WP2 once the future simulations have been conducted with AR5 climate scenarios and land-use scenarios from WP4. This way we will be able to evaluate the response across a range of DGVMs and use the output from GCMs in WP3 to additionally quantify the changes in climate regulation services. In AMAZALERT we thus have not yet assessed the critical limits very precisely, and rather developed the methodology to make such assessment. It will be in cooperation with WP2, WP3 and WP4, when model results are available, that critical values below which a service provision should not fall will be identified and quantified. This will then feed into the synthesis of using ecosystem service assessment for an early warning system.

Initial set of scenarios for use in AMAZALERT land-use modelling

Introduction

The work started with an evaluation of existing scenarios that could bear relevance for AMAZALERT. It was foreseen that a couple of sets would emerge that could be used to kick-start the process of developing scenarios for Brazil and the Legal Amazon. Indeed, two sets of scenarios were identified that were highly relevant to the Brazilian context, the goals of the AMAZALERT project and the scenario process that was being envisioned. Those sets are:

1. The new IPCC-guided scenarios that are being developed for the Fifth Assessment Report (AR5). These scenarios consist of a set of 5 climate change scenarios (Representative Concentration Pathways – RCPs) and a set of 5 socio-economic scenarios (Shared Socio-economic Pathways – SSPs), and will be accompanied by a set of policy scenarios (Shared Policy Assumptions – SPAs). Deadline of completion of the SSPs, that are particularly relevant for WP4: submitted to a peer-reviewed journal by the end of 2013.
   Crucial aspect: these are scenarios that are very recent, have a specific component to include regional studies, and that are on the same topic as AMAZALERT.
2. A set of scenarios ('visions') for Brazil, developed by an expert panel, composed of mainly invited researchers from INPE's Earth Science System Center (CCST). This is a set of 2 scenarios, later expanded to 4. Deadline: scenarios are being developed.
   Crucial aspect: these are scenarios that are for the same region, and that are partly developed by the same researchers that are included in AMAZALERT.

For these and other reasons, it was concluded that both the new global IPCC-lead and the new Brazilian CCST scenarios would need to be part of the AMAZALERT scenarios. Particularly seeking a 1:1 match with the CCST scenarios (see Figure 1) was regarded to be needed. There is a fairly strong correlation between the CCST scenarios and the SSPs (Vision A = SSP1; Vision B = SSP4; Vision D = SSP3; Vision C = SSP5).

Below both scenario sets will be described in more detail. Focus is on IPCC's SSPs, as they are considered to be the initial scenarios to define the global and continental context within which changes in AMAZALERT will be analysed.

Initial global and continental scenarios - the new set of IPCC-guided scenarios

The IPCC's upcoming 5th Assessment Report (AR5) intends to inform stakeholders about the options they have in order to manage climate change. To do so, a coherent analysis of adaptation and mitigation options should be carried out in order to inform them about the costs, benefits and risks of these options. An essential prerequisite is an improved coherence across the IPCC Working Groups in assessing projected climate change, its impacts, the degree to which adaptation and mitigation policies can reduce climate change and its impacts, and the costs of action and inaction.

The IPCC has decided not to carry out its own scenarios. Instead the IPCC intends to benefit from the scenario processes designed and carried out by the scientific community. This is a consequence of the IPCC's intention to be policy relevant without being policy prescriptive. If it is to avoid policy prescriptions the IPCC must explore a wide range of relevant options of adaptation and mitigation. The costs and risks of different options hinge on facts but also on societal choices. Therefore, the IPCC has to be explicit not only on facts (i.e. parameters, model structure) but also on the underlying value systems determining mitigation and adaptation options. In addition, policy-makers want to understand the intended and the unintended consequences of their choices. Without a consistent scenario process, the IPCC cannot provide these crucial insights.

Box 1: IPCC terminology/acronyms
RCP: Representative Concentration Pathways
SSP: Shared Socio-economic Pathways
SPA: Shared Climate Policy Assumptions
CM: Climate modellers

The new scenario process began with the creation of Representative Concentration Pathways (RCPs); scenarios designed to help climate modellers explore the range of potential future greenhouse emissions and concentration pathways. Following the development of the RCPs, Moss et al. (2010) calls for a "parallel phase" in which the climate modelling community uses the RCPs to develop ensembles of climate change scenarios while the IAM and VIA communities jointly develop new scenarios that could be used for mitigation/adaptation studies.

In principle, the IPCC AR5 proposed scenario development approach is highly compartmentalised. Table xxx shows the basic lay-out: The **rows** represent four RCPs that correspond to certain greenhouse gas concentration developments. These will be used by the CM community to link them to certain ranges of temperature, sea level and precipitation. As such, the rows represent the biophysical system dynamics and the effect of climate change. In the **columns**, there are five socio-economic pathways (SSPs). These represent five distinct paths of development of the socio-economic system, focusing on mitigation and adaptation potential. The SSPs will *not* include adaptation/mitigation options or climate policies. Finally, the **cells** are the integrated scenarios where assumptions on climate, the socio-economic system and adaptation, mitigation and climate policies integrate. Note that this approach assumes that SSPs and RCPs can be developed independently, while shared climate policy assumptions (SPAs) will always be in response to both a certain RCP and a certain SSP. The exact approach of developing SSPs is still being discussed. At the time of writing, it was being announced that decisions were going to be taken in early 2014.

In short, the IPCC is specifically addressing "the VIA community" and their approach to new scenarios bears large similarities with the logic of AMAZALERT. In fact, the stories as are developed for Brazil here are very similar to the SSPs from the IPCC, while their SPAs are very closely connected to the policies that are being discussed in WP4. There are thus large possibilities to link to the IPCC process.

Table 3: IPCC AR5 proposed scenario development approach showing the connection between RCPs, SSPs and SPAs.

Representative Concentration Pathway (RCP, W/m²)	**Climate (T, P, sea level)**	**Shared Socio-economic Pathways (SSPs)**				
		SSP1	SSP2	SSP3	SSP4	SSP5
2.6						
4.5				SPA		
6.0						
8.5						

2.1 Shared Socio-economic Pathways (SSPs)

The SSPs have three components:

1. Narrative stories
2. Tables with a qualitative indication of assumptions of a number of elements
3. Quantitative estimates for a number of key model variables, based on 1 and 2

This document will deal predominantly with the narrative stories, but the tables and key model variables will be available for use within AMAZALERT.

Overview

The set of stories that emerged from the Boulder meeting are a first version of the narratives that are part of the SSPs, but which are currently being developed further. The stories are partly similar to the SRES scenarios, and partly new. They are located around two axes which represent challenges to adaptation (axis 1), i.e. the challenges which make it difficult for society to adapt to the effects of climate change, and challenges to mitigation (axis 2) i.e. the challenges which prevent society from effective reduction or mitigation of climate change itself. The SSPs are arranged within this notional space as shown in Figure xxx.

Their fit to the SRES scenarios is as follows: Three SSPs (SSP1, SSP3, SSP5) are similar to the following SRES scenarios (B1, A2, A1, respectively). Two of them are new, one of which (SSP4) provides an interesting contrast of high challenges for adaptation but low challenges for mitigation, while the other one (SSP2) provides a middle-of-the-road position.

In the following, we summarise the five SSPs, extracted directly from O'Neill et al. (2012), and consider their potential relevance in a Meso- and South American context for AMAZALERT.

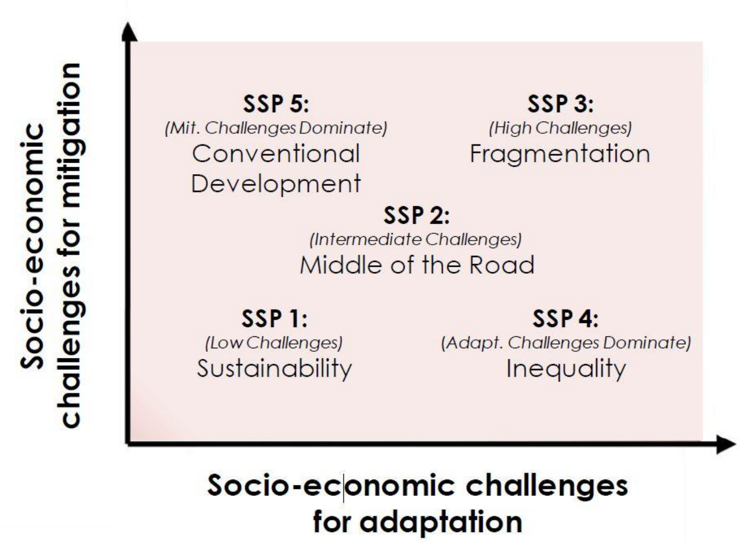

Figure 4. Five SSPs as developed during the Boulder meeting, separated along two main axes, challenges for mitigation and challenges for adaptation. Figure taken from O'Neill et al. (2012).

SSP1 – Sustainability (Heaven)

Summary

This is a world making relatively good progress towards sustainability, with sustained efforts to achieve development goals, while reducing resource intensity and fossil fuel dependency. Elements that contribute to this are: a rapid development of low-income countries, a reduction of inequality (globally and within economies), rapid technology development, and a high level of awareness regarding environmental degradation. Rapid economic growth in low-income countries reduces the number of people below the poverty line. The world is characterized by an open, globalized economy, with relatively rapid technological change directed toward environmentally friendly processes, including clean energy technologies and yield-enhancing technologies for land. Consumption is oriented towards low material growth and energy intensity, with a relatively low level of consumption of animal products. Investments in high levels of education coincide with low population growth. Concurrently, governance and institutions facilitate achieving development goals and problem solving. The Millennium Development Goals are achieved within the next decade or two, resulting in educated populations with access to safe water, improved sanitation and medical care. Other factors that reduce vulnerability to climate and other global changes include, for example, the successful implementation of stringent policies to control air pollutants and rapid shifts toward universal access to clean and modern energy in the developing world.

Plausibility and usefulness for AMAZALERT

The SSP1 pathway is very close to the SRES scenario B1, and bears similarities to the 'Policy First' scenario from GEO-3/4. Many things fundamentally improve very rapidly (reach MDGs within a decade). This is certainly not impossible, and particularly for the developed world, it is already in reach. For Latin America, however, there are questions on plausibility and credibility. This could serve as the most positive case for both mitigation and adaptation.

SSP1 Latin America - Latin Green:

It will be challenging to construct an exploratory story that will lead to a totally sustainable region within the next 40 years. One possibility would be to assume that all of Brazil's efforts to strongly reduce deforestation are successful. That this leads to a strong improvement of Brazil's position in the international markets, which in turn boosts the economy. Strongly increasing demand for sustainable products stimulates R&D of green technologies. The enormous success of Brazil quickly leads to implementation of similar policies throughout the region, with countries such as Mexico but also Bolivia leading the way.

There is willingness to embrace and implement all the policy options considered in AMAZALERT. As far as the main sectors that AMAZALERT is involved with are concerned, we interpret the following: With progressive implementation of REDD-type policies deforestation and degradation can be completely controlled, including illegal logging, due to high levels of education for the whole population, strong governance and high environmental awareness. Commercial forest management is run on sustainable principles. In agriculture, production increases mainly as a result of technological developments in improving yield on existing land, rather than increasing agricultural area. Biofuel crops may increase in area initially due to a focus on alternative energy sources, while trade crops and local food crops benefit from continuing international trade coupled with a focus on regionalisation. The agricultural sector most likely to stagnate is the pasture industry, but yields continue to increase in all sectors. Water quality is average to good, depending on implementation of different policies, because the technology and environmental awareness support effective land management to improve it. Water supply solutions are small-to-medium scale, serving populations, agricultural, hydropower and tourism sectors. Disease exposure is reduced and infectious diseases well controlled due to a combination of educated population, careful land management and good health care. There is a strong focus on biodiversity due to high environmental awareness and strong national and international governance, and this includes increasing protected area of forests and other valuable habitats.

SSP2 – Middle of the road

Summary

In this world, trends typical of recent decades continue, with some progress towards achieving development goals, reductions in resource and energy intensity at historic rates, and slowly decreasing fossil fuel dependency. Development of low-income countries proceeds unevenly, with some countries making relatively good progress while others are left behind. Most economies are politically stable with partially functioning and globally connected markets. A limited number of comparatively weak global institutions exist. Per-capita income levels grow at a medium pace on the global average, with slowly converging income levels between developing and industrialized countries. Intra-regional income distributions improve slightly with increasing national income, but disparities remain high in some regions. Educational investments are not high enough to rapidly slow population growth, particularly in low-income countries. Achievement of the Millennium Development Goals is delayed by several decades, leaving populations without access to safe water, improved sanitation, medical care. Similarly, there is only intermediate success in addressing air pollution or improving energy access for the poor as well as other factors that reduce vulnerability to climate and other global changes.

Plausibility and usefulness for AMAZALERT

The SSP2 pathway does not link directly to any of the SRES scenarios. Likewise, there is no scenario archetype that is similar. This is likely to be related to the fact that SSP2 is the scenario that least has its own identity. Most if not all elements are changing moderately, and most seem somewhere between the “heaven” from SSP1 and the “hell” from SSP3. As such, it does not pose a very interesting, nor challenging scenario.

SSP2 Latin America:

We do not further develop SSP2 as qualitative scenario for Latin America. Note that for quantitative purposes, SSP2 might be considered as a baseline/reference scenario, but this need could also be met by SSP4 or SSP5.

SSP3 – Fragmentation (Hell)

Summary

The world is separated into regions characterized by extreme poverty, pockets of moderate wealth and a bulk of countries that struggle to maintain living standards for a strongly growing population. Regional blocks of countries have re-emerged with little coordination between them. This is a world failing to achieve global development goals, and with little progress in reducing resource intensity, fossil fuel dependency, or addressing local environmental concerns such as air pollution. Countries focus on achieving energy and food security goals within their own region. The world has de-globalized, and international trade, including energy resource and agricultural markets, is severely restricted. Little international cooperation and low investments in technology development and education slow down economic growth in high-, middle-, and low-income regions. Population growth in this scenario is high as a result of the education and economic trends. Growth in urban areas in low-income countries is often in unplanned settlements. Unmitigated emissions are relatively high, driven by high population growth, use of local energy resources and slow technological change in the energy sector. Governance and institutions show weakness and a lack of cooperation and consensus; effective leadership and capacities for problem solving are lacking. Investments in human capital are low and inequality is high. A regionalized world leads to reduced trade flows, and institutional development is unfavorable, leaving large numbers of people vulnerable to climate change and many parts of the world with low adaptive capacity. Policies are oriented towards security, including barriers to trade.

Plausibility and usefulness for AMAZALERT

The SSP3 pathway is closely related to the SRES scenario A2, and bears similarities to the 'Security First' scenario of GEO-3/4. As with SSP1 many things change fundamentally, but this time for the worse. Contrary to SSP1 this is more difficult to imagine for developed countries than for the developing world, and some aspects of the storyline reads very much like the present day reality in parts of Latin America. This can potentially increase credibility but decreases the added value of developing this particular scenario. For AMAZALERT, we might be in need of an even gloomier scenario.

SSP3 Latin America – Fortress not forest:

There are many ways to kick-start a downward spiral of protectionism, deglobalisation, inward-looking and environment-ignoring attitudes. It seems plausible that it starts with trade barriers, collapse of (agricultural) export, unemployment and poverty. Note that in terms of deforestation and environmental degradation, this might not be necessarily bad. Ceasing demand for beef, timber, feed (soya), and milk from Europe, Asia and the US might have positive consequences, at least in the short run. The outside forces are combined with internal issues, bringing back memories from a not so distant past. Dictators, corruption, guerrilla warfare and violence all (re)appear in more and more countries. As international (monetary) aid dwindles, the situation worsens quickly. This scenario offers many possibilities for tipping points in social and economic systems towards a dark future that cannot be easily escaped from. However, SSP3 perhaps does not offer the rapid land use changes which might trigger environmental tipping points.

With particular relevance to AMAZALERT, this is one candidate for an extreme environmental scenario, but is largely incompatible with most of the policies envisioned within AMAZALERT. This is either because the social context is not consistent with a desire to implement these policies or, even if policies are enacted, the governance is so weak and social and political instability are so great that they are not enforced at all. The net result is the same in terms of land use change. In the forest sector, deforestation and degradation continue, but arguably at lower rates than have been observed historically, this is because decreasing world trade and low demand for biofuels mean that the main driver of deforestation is land clearance for subsistence and local agriculture rather than industrial scale clearance for e.g. soybean or sugarcane. Illegal logging probably remains high due to corruption. Agricultural area increases but crop yields do not. Both biofuels and trade crops decline in importance relative to local food crops and pasture. Water quality is poor due to poor agricultural practices. Water supply focuses on small to medium reservoirs where disease, hydropower and leisure are not considered. Disease exposure is high due to population expansion into deforested regions coupled with poor water quality and low levels of education and healthcare. There is little local demand and virtually no international demand for leisure and tourism. Biodiversity is given little consideration.

SSP4 – Inequality

Summary

This pathway envisions a highly unequal world both within and across countries. A relatively small, rich global elite is responsible for much of the emissions, while a larger, poorer group contributes little to emissions and is vulnerable to impacts of climate change, in industrialized as well as in developing countries. In this world, global energy corporations use investments in R&D as hedging strategy against potential resource scarcity or climate policy, developing (and applying) low-cost alternative technologies. Mitigation challenges are therefore low due to some combination of low reference emissions and/or high latent capacity to mitigate. Governance and globalization are effective for and controlled by the elite, but are ineffective for most of the population. Challenges to adaptation are high due to relatively low income and low human capital among the poorer population, and ineffective institutions.

Plausibility and usefulness for AMAZALERT

The SSP4 pathway does not bear similarities to any of the SRES scenarios. It most resembles the Fortress World scenario as developed by the Global Scenario Group, and as such it also has elements of Security First from GEO-3/4. Yet, the global elite and multinationals are willing to explore low carbon energy options, mainly due to insecurity and high costs of conventional fossil fuel supplies. SSP4 contains a mix of the doom of SSP3 with some potential of developing non fossil fuel energy sources as found in SSP1.

SSP4 Latin America: Indifferent dictators

For this region, SSP4 seems a positive variation of SSP3 in terms of potential climate mitigation, but a negative version in terms of environmental destruction. The elite are somewhat larger, but have little regard for social development, and together with large multinationals continue to extract natural resources from the environment from forestry, agriculture and some alternative energy sources, with no regard for environmental consequences. There is strong indifference of the elite towards social, human, and natural capital of the non-connected. The trajectory can differ depending on how the storyline is interpreted. In one interpretation the elite have no inherent interest in the environment, instead pursuing global trade opportunities which just happen to include biofuels. Another interpretation is that the elite have some interest in applying REDD-type policies due to their desire to access carbon markets and remain world players, however there is no interest in implementing the additional safeguards for biodiversity and ecosystem services so these policies are not considered.

For AMAZALERT this represents a potential worst case scenario with respect to land use change, while allowing the possibility to explore at least some of the policy options considered within the project, depending on how it is interpreted. In the forest sector both deforestation and degradation continue or increase to previously observed high rates driven by high demand for continued forest clearance for large scale agriculture. Rates of illegal logging are also high due to the potential for quick profit and generally low environmental awareness. Implementation of REDD-type policies has the potential to slow both deforestation and degradation, but not completely due poor governance and high corruption. In the agricultural sector, biofuels and trade crops increase strongly in area and in yield due to large-scale agrochemical use with little concern for the environment. Livestock area also increases due to export of beef. Food crops are not seen as a priority by the elite as they can easily buy in these commodities and indeed prefer international rather than local cuisine. High fuel costs mean that high-value crops are located close to infrastructure such as transport networks, processing plants and airports. Water quality is correspondingly poor due to high agrochemical use with little concern for local health and the environment. Water supply solutions are large-scale, primarily serving the larger cities, but also provide hydropower to boost local energy security and provide recreation opportunities for the elite. As a result they are sited relatively close to large cities where possible, but with no concern for disease implications. Disease exposure and incidence are high due to settlement of cleared forest areas combined with poor sanitation and health care and low levels of education of the rural population. There is limited demand for tourism and recreation serving the elite. Biodiversity is given little consideration.

SSP5 – Conventional development (Development first)

Summary

This world stresses conventional development oriented toward economic growth as the solution to social and economic problems through the pursuit of enlightened self-interest. The preference for rapid conventional development leads to an energy system dominated by fossil fuels, resulting in high GHG emissions and challenges to mitigation. Lower socio-environmental challenges to adaptation result from attainment of human development goals, robust economic growth, highly engineered infrastructure with redundancy to minimize disruptions from extreme events, and highly managed ecosystems.

Plausibility and usefulness for AMAZALERT

The SSP5 pathway relates to the SRES scenario A1, and bears similarities to the 'Markets First' scenario of GEO-3/4. Yet, there is not a 1:1 match. SSP5 is more negative in terms of climate change impacts, particularly because of the large focus on use of fossil fuels. The starting point of low adaptation and high mitigation challenge resulted in something deceivingly familiar to an A1 future, but with important differing aspects.

SSP5 Latin America – Educated destruction:

This is perhaps one of the more difficult scenarios to develop for the region. Because of the large recent changes in some of the big countries, it is not easy to interpret the effects of current globalisation forces. The focus on fossil fuels can be related to potential (large) new oil & gas fields, also in the Amazon forest, which can lead to large-scale destruction of the natural forest. Note that this scenario will have many positive effects related to the agricultural sector and land use:

- Cheap energy – boost for mechanisation?
- Cheap fertiliser
- No incentive for biofuels: gradually less land occupied.
- Large demand for beef, soya and other export crops.

There is a fundamental tension in many aspects between economic development stimulating the economy by providing cheap energy at the expense of the environment, while on the other hand social change is towards equity, high education, low crime and corruption etc.

In the forest sector, deforestation and degradation continue at current rates but with implementation of relevant policies can both be halted completely due to strong governance, however there is relatively little interest in implementing wider policies incorporating safeguards for biodiversity and ecosystem services, except where there is clear national interest or technical fixes. In the agricultural sector productivity increases due to technological advances, although land area remains more or less constant with implementation of REDD-type policies. Biofuel crops decline in importance due to widely available and cheap fossil fuels, while other crop types increase, particularly trade crops and livestock due to specialisation of agriculture and high demand for meat. Crops not grown locally can be easily imported. Irrigation and improvements in crop varieties broaden the land suitability ranges for different crop types. Although fuel prices are low, the focus on trade means these crops are located close to markets, transport and processing infrastructure. Water quality is average despite technological advances due to high use of agrochemicals, but there is potential for it to improve further due to strong governance and highly managed landscapes which allow enforcement of good land management practices optimising fertiliser and pesticide application rates and careful location of crops relative to water courses. Water supply solutions are large-scale and facilitate water-based recreation but there is little interest in hydropower. Disease exposure is reduced to low levels of forest clearance, good education and healthare and highly managed landscapes controlling vectors where necessary. Tourism and recreation strongly increase due to local and international demand. There are mixed benefits for biodiversity, driven to a greater extent by local-level environmental awareness rather than national policies.

Initial Brazilian scenarios – the CCST visions

A set of scenarios ('visions') has recently been developed for Brazil by an expert panel, composed of mainly invited researchers from INPE's Earth Science System Center (CCST). This is one of the first attempts to develop a set of national qualitative (and quantitative) stories that lay out a number of plausible futures for Brazil. They are termed "visions" as they combine exploratory and normative elements (see Figure xxx).

Vision A combines high social, environmental and economic development. It represents a "*desired*" (normative) future, from the perspective of the expert panel involved in the process. In this scenario, we envision that government and society will reverse the structural situation of social inequities in Brazil, while taking fully into account the environmental and economic dimensions. In this vision, the land use system reflects this positive situation. Rural areas would be a mosaic of well managed sustainable territories, providing ecosystem services and food security for the country population. There would be a balanced relation between rural and mid-sized urban centers relation, in terms of agricultural production, services and industrial jobs.

Vision B brings a commodity oriented economy with sufficient respect to environmental laws, due to the international environmental awareness, reflected in consumer pressure. Social indicators would grow as a result of macro-economic success, following the current trends, but governments in the future decades prioritize GDP growth over reversing structural social problems and inequities. Vision B can be considered as a "business-as-usual" for Brazil. Although deforestation-driven greenhouse emissions, for instance, would not be a major concern in this scenario, society remains with unequal access to natural resources, land, markets, credit, services and job opportunities. Besides, we also envision food becomes more and more expensive due to the badly planned rural-urban relation in terms of food security and lack of attention to smallholder agriculture. Most of the land would be controlled by large companies. However, those companies do follow the environmental legislation ruled by international certification processes in the context of well established green markets. This second scenario could also be called an "Unequal green world".

Also included were two Low Environment Development scenarios, C and D, in which natural resources would be severally depleted in 2050. They are similar to previous "pessimist" or "business-as-usual" scenarios, including high rates of deforestation in all biomes. We assume in these scenarios that the increase in demand for food, both national and international, induced a relaxation of environmental laws, causing both direct and indirect land use changes. The difference between Scenarios C and D lies in the social development indicators. In Scenario C we envision an urban world, with high economic and social development lead by multiple sectors (TI, industry, services, tourism), based on high quality education and technology development (in the model of what we see today in Asian countries). Finally, scenario D has only GDP growth, no serious efforts to change the social inequities, education or protecting the natural resources, in a model that resembles the XIX and XX centuries processes. However, due to the current global and national concern with environmental changes, we consider Scenario C and D comparatively less probable than Scenario B.

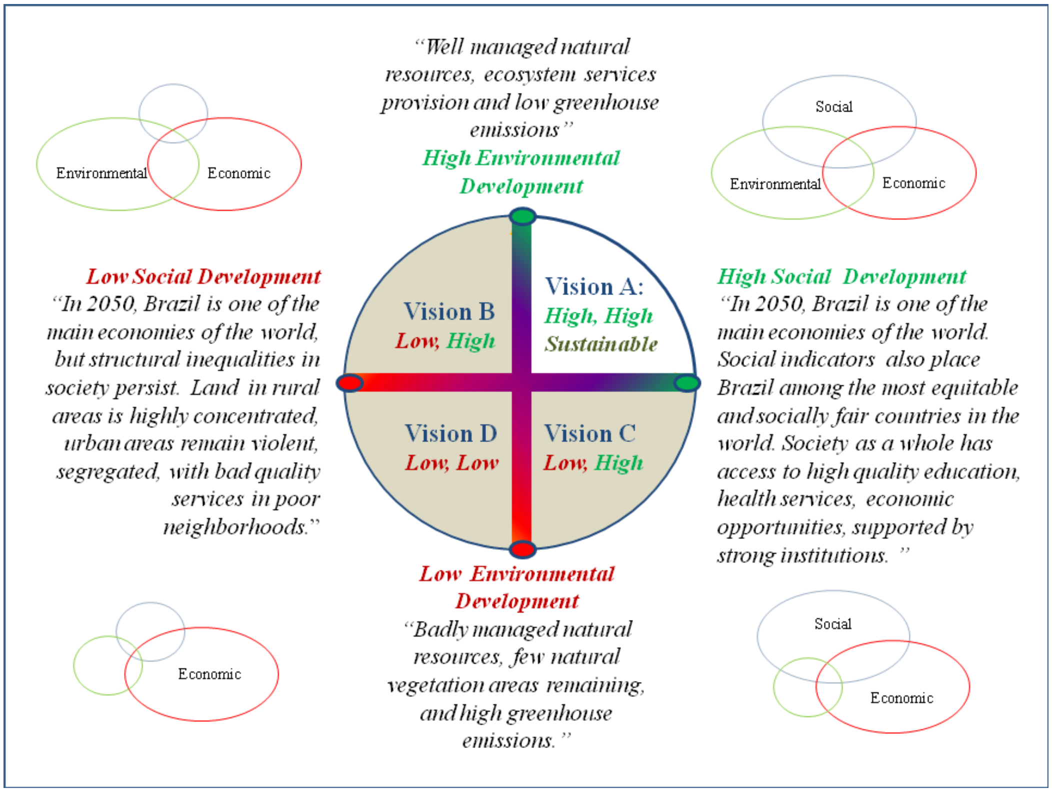

Figure 5. Four visions for Brazil: The CCST scenarios.

Scenario development method

Originally, the methodology was to develop explorative, qualitative scenarios that would be quantified using a land use model. These products would be used to develop normative scenarios that would include policies, which would bring together the two main aims of the WP. While this overall concept remains, the order of the steps does not. The newly devised method marries the approach taking by the CCST scenarios with the original ideas of AMAZALERT:

I. Starting point is the set of partly normative CCST scenarios with a desired and undesired vision that will be downscaled for the Legal Amazon, also using the SSPs.
II. These will be quantified using the LuccME modelling framework
III. Quantified results will be used during the first workshop that will enriching scenarios, while directly also discussing policies

This in turn, had one important consequence: We need to wait until the final versions of both sets of scenarios are available. While this would lead to a delay in the first stakeholder workshop, we would make up for that lost time by running in parallel the quantification and further qualification of scenarios.

Conclusions

Ecosystem services

In the stakeholders workshop (third day of the AMAZALERT kick-off meeting), the priority Amazon ecosystem services and their drivers of change were identified for the AMAZALERT partners. Seven ecosystems were services selected as the most relevant in the prioritization: *consumptive use*, *carbon storage in intact forests and soils*, *maintenance of favourable climate*, *subsistence agriculture*, *fishing*, providing living space to wild plants and animals, and *protection of biodiversity*. Between these, *protection of biodiversity* is the service considered the most important service for the AMAZALERT consortium.

From the modelling perspective, except *subsistence agriculture* and *fishing*, all other ecosystem services can be quantified using output from DGVM and GCM either directly or indirectly. Results from model experiments in WP2 and 3 can be used to quantify services related to production and regulation as well as habitat integrity. In the case of habitat-related services and water-related services further post-processing of the model data is required in order to obtain the information that is expressed by the service.

Critical limits for ecosystem services will only be obtained by further analysis of simulation results from WP2 and 3, where e.g. critical limits for climate regulation can be quantified, and by incorporating insights from WP4 through expert consultation on critical water levels for hydropower generation or transportation.

Initial scenarios

There are a large number of existing sets of global, Latin America and Brazilian scenarios. For use in AMAZALERT, the following sets of scenarios were selected as being most relevant and most useful as initial set:

b. Global: set of 5 IPCC-guided socio-economic scenarios (SSPs)
c. Latin America: continental stories based on the global SSPs
d. Brazil: set of 4 CCST visions

This set provides a set of mostly qualitative scenarios that sketch plausible future developments of the socio-economic, institutional, and political context. Most important additional selection criteria includes “currentness”, time horizon, and scientific acceptance.

There is a fairly good match between the Brazilian CCST visions and the global/continental SSPs, which enables linking them. In short, this initial set of scenarios will allow us to kick-start the process of participatory scenario development in WP4 of AMAZALERT.

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ANNEX 1 Version of the questionnaire adjusted during the kick-off meeting.

Workshop on priority ecosystem services in the Amazon and its main drivers of change

Name: **Institution:** **Country:** **email:** **date:**

Please answer the question 1: ***Which are the key ecosystem services in the Amazon and why?*** For this, fill out the second column of table 1 by choosing the main ecosystem services, put 1 for the most important, 2 for the medium and 1 for the less important. If you consider that an ecosystem service is not important please leave it blank. In the third column explain those ecosystem services marked as high priority.

Table 1. Ecosystem services prioritization

Ecosystem functions	Ecosystem goods and services		Prioritize (1: High; 2: Medium; 3: Low)	Why? (Explain those ecosystem services marked as high priority)
Regulation functions	Water cycle	Consumptive use		
		Natural floods		
		Ground water		
		Reduction of droughts		
		Hydropower		
		Transportation		
	Soil	Erosion prevention		
		Carbon storage		
		Provision of nutrients		
	Pest control			
	Climate	Carbon sequestration		
		Maintenance of favorable climate		
		Reduction of extreme events		
		Local climate		
Production functions	Food	Cash crops agriculture		
		Subsistence agriculture		
		Hunting/gathering		
		Fishing		
	Feed			
	Fiber			
	Fuel	Firewood		
		Agricultural waste		
	Timber	Commercial		
		Subsistence		
Information	Recreation			
	Inspiration			
	Other:			
Habitat function	Providing living space to wild plants and animals			
	Protection of biodiversity			
	Collection of medical plants			

Others:		

Please answer the question 2: ***Which are the main drivers of change?*** For this, choose the main drivers of change for each of the ecosystem services that you selected in the table 1 and fill out table 2.

Table 2. Drivers of Change

	Drivers of Change										
Ecosystem functions	**Ecosystem goods and services**		**Deforestation (land use change)**						**Climate change**		
			Large scale agriculture production	Small scale agriculture production	Wood industry (legal and illegal)	Construction of: river dams, roads, settlements, expansion of cities	Cattle raising	Slash and burn	Change of radiation	Tempe-rature	Precipitation (extreme events: droughts, floods, storms)
Regulation functions	Water cycle	Consumptive use									
		Natural floods									
		Ground water									
		Reduction of droughts									
		Hydropower									
		Transportation									
	Soil	Erosion prevention									
		Carbon storage									
		Provision of nutrients									
	Pest control										
	Climate	Carbon storage in intact forests and soils									
		Maintenance of favorable climate									
		Reduction of extreme events									
		Local climate									
Production functions	Food	Cash crops agriculture									
		Subsistence agriculture									
		Hunting/gathering									
		Fishing									
	Feed										
	Fiber										
	Fuel	Firewood									
		Agricultural waste									
	Timber	Commercial									
		Subsistence									
Information	Recreation										
	Inspiration										
Habitat function	Providing living space to wild plants and animals										
	Protection of biodiversity										
	Collection of medical plants										

Please answer the question 3: **Which stakeholders should also be considered in the AMAZALERT project?** For this, fill out table 3 with the contact information of the key stakeholders.

Table 3. Stakeholders that also should be considered in the AMAZALERT project

Name	Sectors (Government/ NGO/ Research/civil society)	Contact person	Country	Email	Phone	How to reach stakeholders*

***(a) email, (b) personally (interviews), (c)regional workshop, (d) local workshop**

Please let us know the data sources for the ecosystem services

Feedback is really important for us; please write any comment, or suggestion. Thank you very much for your time.

ANNEX 2 Version of the questionnaire send to the Bolivian stakeholders.

Priorización de servicios ambientales en la Amazonía boliviana y sus principales amenazas (Proyecto: AMAZALERT)

Funciones Ecosistémicas	Servicios Ambientales		Priorización (**Alta**; **Media**; **Baja**)	¿Cuáles son las principales amenazas para estos servicios ambientales?
Funciones de regulación	Ciclo del Agua	Suministro de agua para consumo humano		
		Mantenimiento de áreas de inundación		
		Mantenimiento del agua subterránea		
		Reducción de sequías		
		Trasporte fluvial		
	Suelo	Prevención de la erosión		
		Almacenamiento de carbono		
		Provisión de nutrientes		
	Control de plagas y enfermedades			
	Clima	Mantenimiento de un clima favorable		
		Secuestro de carbono		
		Reducción de eventos extremos		
Funciones de producción	Alimentos	Agricultura a gran escala		
		Agricultura de subsistencia		
		Caza de subsistencia / comercial		
		Pesca de subsistencia / comercial		
	Fibra			
	Combustible	Biomasa para combustible		
		Desechos de agricultura		
	Madera	Madera para uso comercial		
		Madera para uso de subsistencia		
Funciones de hábitat	Espacio de vida para las comunidades indígenas			
	Recolección de plantas medicinales			
	Protección de la biodiversidad y su hábitat			
Información	Recreación			
	Inspiración			
Otros	Polinización			

Le agradeceré también si puede indicarnos qué otras instituciones y/o personas deberían ser considerados en el alcance de esta encuesta:

Nombre (organización)	Persona de contacto	Lugar, ciudad	Email	Teléfono

ANNEX 3 Final version of the questionnaire sent to the RAISG network members and the list of stakeholders suggested by the UNAL.

Priority environmental services in the Amazon and its main drivers of change

AMAZALERT project www.**eu-amazalert**.org needs your contribution to identify the main environmental services provided by the Amazon ecosystem and their drivers of changes. Please indicate from what perspective you consider the services provided by the Amazon by checking one or several of the choices below or adding another and then fill out the table on the next page.

Group or perspective:

- ☐ Small-scale farmer
- ☐ Large-scale farmer
- ☐ Timber producer
- ☐ Environmentalist
- ☐ Energy supplier
- ☐ Engaged in transport service supply
- ☐ Mining interests
- ☐ Member Indigenous group
- ☐ Inhabitant of town within the Amazon
- ☐ Citizen of Brazil or other Amazon nation outside of the Amazon region
- ☐ Citizen of non-Amazon nation
- ☐ Policy maker
- ☐ Other (please describe) ____________________________

To fill out the Table, in the column entitled 'Prioritize', put 1 for the most important ecosystem service for you and 2 for the next most important and so on. You may continue numbering for as many services as are important to you. In the third column briefly indicate what you consider to be the main threats to continued provision of the services you have selected, or factors driving its change. Examples: (a) less water may be available for agricultural use due to climate change or withdrawals for industry; (b) prevention of soil erosion may be reduced due to deforestation; (c) carbon storage in forests may be lost due to deforestation, large scale agriculture, logging, construction of roads, fires etc.

Ecosystem functions	Ecosystem goods and services		Prioritize (1: first; 2: second; 3: third most important)	Causes of changes to ecosystem services marked as important
Regulation function	Water cycle	Consumption for agriculture		
		Consumption for Household (drinking & hygiene)		
		Maintenance of regular flooding		
		Ground water		
		Reduction of droughts		
		River transportation		
	Soil	Erosion prevention		
		Carbon storage		
		Nutrients provision		
	Pest control			
	Climate	Carbon storage in forests		
		Maintenance of favorable climate		
		Reduction of extreme events		
	Other: ___________________________________			
Production functions	Food	Cash crops agriculture		
		Subsistence agriculture		
		Subsistence and commercial Hunting		
		Subsistence and commercial Fishing		
	Fiber other than wood			
	Medicinal Plants			
	Habitat for Indigenous Groups			
	Fuel	Firewood		
		Agricultural waste		
	Timber	Commercial		
		Subsistence		
	Other: ____________________________________			
Habitat function	Protection of biodiversity and its habitat			
Information	Recreation			
	Inspiration			
Others:				

Please indicate, which stakeholders should also be considered in the AMAZALERT project? For this, fill out the table below with the contact information of the key stakeholders.

Name (organization)	Contact person	Country	Email	Phone

Feedback is really important for us; please write any comment, or suggestion. **Thank you very much for your time.**