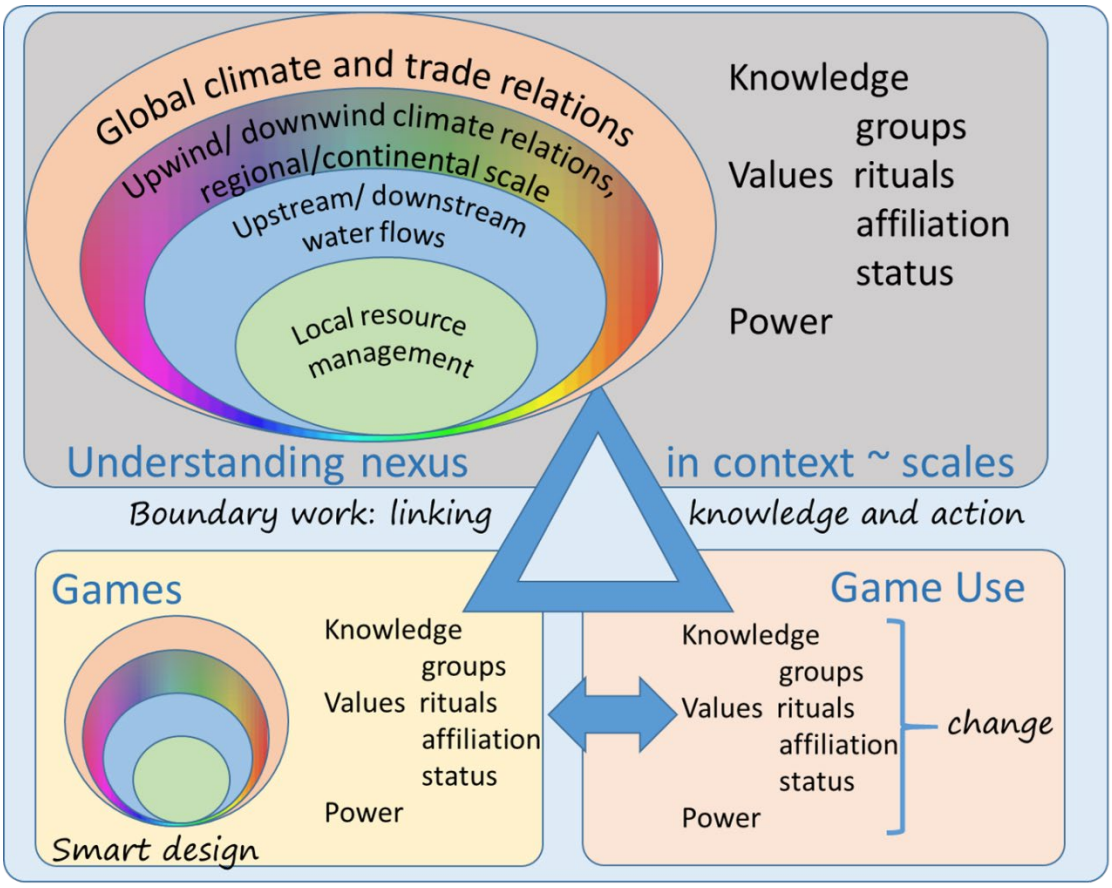
Scenario Evaluation for Sustainable Agro-forestry Management (SESAM)



Wageningen School of Social Sciences

PRODUCTION ECOLOGY & RESOURCE CONSERVATION

Wimek

1. Title of the programme

Scenario Evaluation for Sustainable Agro-forestry Management (**SESAM**)

2. Applicant(s)

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3. Programme summary

Among the **Sustainable Development Goals** (SDGs) three broad groups coexist: **A)** articulating demand for further human resource appropriation, **B)** sustaining the resource base, and **C)** redistributing power and benefits. Agriculture and forestry jointly interact with all three groups of goals, with agroforestry as an opportunity to transcend barriers between these separate policy domains (van Noordwijk et al. in press). However, there is often a difference of interests among stakeholders involved in water management, agriculture, and forestry. As a result, a disjoint policy landscape might exist, creating dysfunctional policies for some of the stakeholders. In particular, developing further institutional space for integral 'all-land-uses' approaches requires a more effective voice of local stakeholders in the process of landscape and green economy planning than is currently common.

Novel **scenario evaluation tools** are needed to support actors in landscape management to address the SDG agenda in all its complexity, while creating a more level 'playing field' for decision making in which local knowledge, voices and preferences are combined with external technical knowledge and policy frameworks. In the emerging field of 'serious games' there is a growing number of local success claims (e.g Speelman and Garcia-Barrios, 2010; Garcia-Barrios et al., 2017; Garcia et al., 2018), but insufficient experience with going to scale. **SESAM** aims to develop replicable smart game designs adapted to a range of local contexts, recognizing the multiple coexisting discourses on priority actions in 'greening' growth (Amaruzaman et al. 2017). SESAM will thereby *open the door* to the widespread and responsible use of serious games for governing (agro)forest landscapes.

The overall objective of the SESAM programme is to: Develop interdisciplinary participatory **Scenario Evaluation Games (SEG)** for supporting and enhancing social learning and action by actors involved in multi-level decision-making processes around the **forest-water-people nexus**, and understand their impact on participatory decision-making on **water** and **(agro)forest landscape management**.

The SESAM programme will run from July 2019 to July 2015 and will be based on a **case study approach** and consists of **17 subprojects** i.e. **2 postdoctoral projects** (PD projects) and **15 PhD projects**. The case studies originate from 7 countries, *Indonesia, Kenya, Uganda, Suriname, Ecuador, Peru*, and *Brazil,* and represent a diversity of distinct socio-cultural and political economic drivers of forest and water exploitation. Two PD projects will develop **methodological tools** to guide the PhD serious gaming research as well as perform a large **cross-case study** comparative analysis.

The SESAM consortium is composed of **6 Universities**, **5 research organisations** and **6 civil society organisations**, all who have confirmed their **interest** and **support** for this innovative programme. This **interdisciplinary consortium** will collaborates in the facilitating, guiding and supervising the research performed by the PD and PhD candidates. An **international advisory** board will form a sounding board and a link to the wider gaming network. The programme has a total budget of **M € 2.16** of which 45% will be co-funded by external sources and 55% will be requested from **INREF** (around M€ 1.2,-).

Expected results
SESAM will result a total of **15 PhD theses**, at least **30 MSc theses** and in a multitude of **scientific publications.** In addition, the concepts and results from the programme will be communicated to the wider public through a series of **knowledge clips**, (training) workshops and the incorporation of SESAM research in academic curricula at the six collaborating Universities. SESAM will develop much needed improved methodological tools for game design, use and analysis. The expected results of the **SESAM programme** will strongly contribute to **maturing** of the upcoming field of serious gaming for complex landscape management.
Thereby, **putting** Wageningen University in the *frontline* of the **upcoming research field** of **serious gaming** for complex landscape management.

4. Detailed programme description

Forest-Water-People Nexus
Approximately half of the human population needs to cope with too much, too little and/or low quality water. The complex relationships between positive (utilization) and negative (floods, landslides, droughts, pollution) aspects of water in its interaction with both changing land cover and changing climate are among the most salient challenges for achieving sustainable development in vulnerable tropical regions around the world, especially in the global South (e.g. Nobre et al. 2016; Ellison et al. 2017). No fewer than 90% of all 'natural' hazards in these vulnerable regions are water-related, and the frequency and magnitude of both acute (e.g. flooding) and long-term (e.g. drought) events are expected to increase as a result of ongoing deforestation, large-scale land-use and climate change (UNISDR, 2015). Preventing water-related disasters, both acute and long-term, is one of the biggest challenges now and in the future.

Reducing the frequency and magnitude of water-related hazards is related to the effective management of tropical (agro)forests. In short, the degree of forest cover loss affects the availability of ground, surface and atmospheric water (Ellison et al., 2017) (**Figure 1a**). Decisions by land-users and policy makers alike to deforest or reforest will change the position of the landscape on the forest transition curve (**Figure 1b**) and has direct consequences for the availability of water in those landscapes, which in turn influences both the ecological vulnerability of agro-ecological landscapes and the social vulnerability of communities dependent on them for their livelihoods (Dewi, 2017). However, while the relationship between forests and water is generally understood, stakeholders differ in their perceptions on how this relationship should be translated into a widely accepted framework for decision making and action.

There are currently competing schools of thought that are used to shape decision making – all of which understand the position and relationship of water, trees and land users differently (Creed & van Noordwijk 2018). First, the so-called "*Paradise lost*" paradigm encompasses a view in which trees and forests are unconditionally good for water security (i.e. more trees equals higher water security). Second, the "*Blue-Green water competition*" paradigm, with blue water referring to liquid water in rivers and aquifers optimised against green water cycles through forest evaporation and ground and atmospheric transportation. Third, the "*Full Hydrological cycle*" paradigm which goes beyond the blue-green water competition to emphasise the influence of location, scale and specific dependent factors shaping water availability (**Figure 1a**). Each of these paradigms privilege different land-use

decisions related to both water and forest management ranging from the local to regional scales. But more importantly they also confine solutions to a set of largely technical responses that may neither reflect the realities of communities dependent on these landscapes nor enable an adequate response to the forest-water-people interactions at different points along the forest transition curve.

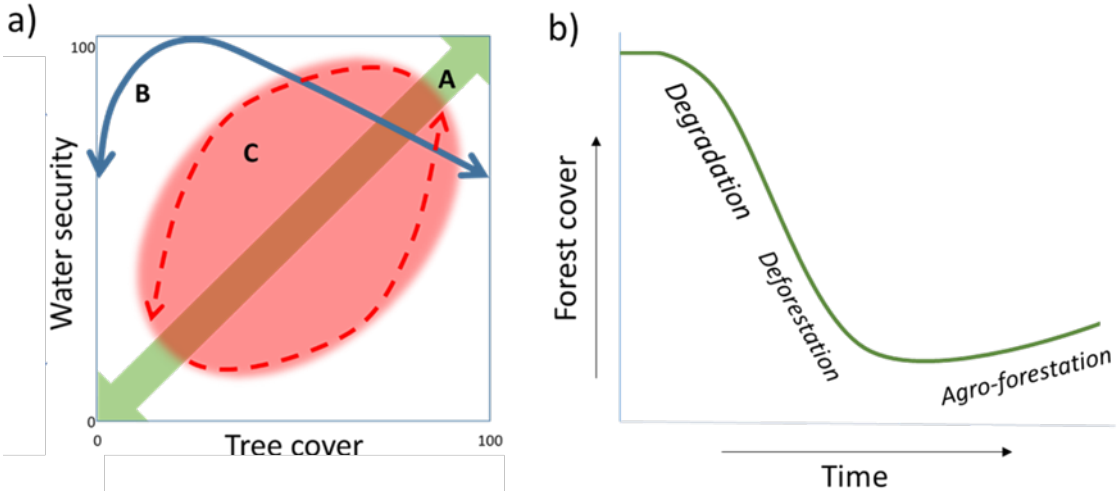

Figure 1: a) The currently co-existing ways of understanding in the *Forest-Water-People* nexus. The three main paradigms are shown: **A**- the so-called "*Paradise lost*" paradigm, **B** – the "*Blue-Green water competition*" paradigm, and **C** – the "*Full hydrological cycle*"; **b)** The forest transition curve depicting the relation between forest cover and time and the various processes that describe how landscapes might move along the curve.

There is growing recognition in both science and policy that decision making processes for managing the interaction between forests and water along the forest-transition curve need to be scale sensitive, adaptive and able to incorporate both ecological and socio-political drivers of change. This means moving beyond the dogmatic application of forest-water paradigms that narrowly preference either engineering-based or community based solutions to water management (Creed & van Noordwijk 2018). Instead participatory decision making processes increasingly have the aspiration to bring together affected stakeholders to (1) understand context-specific forest-water interactions, (2) become aware of the wider political and economic drivers that impact forest-water interactions, and (3) make decisions over how to change their land use practices (Walker et al. 2002; Reed, 2008; Scholz et al. 2013; Angelstam et al. 2013). More fundamentally, such processes may also (re)shape wider scientific debates and paradigms.

But while participatory and adaptive landscape-level decision making is widely promoted in science and policy (see e.g. Munaretto et al 2014), there are no proven approaches for realising such aspirations. The approaches that do exist are predominantly-based on scenario processes that do not correspond to immediate context of local stakeholders, or lack the capacity to triggers and stimulate true engagement and active reflection among groups of stakeholders. Therefore, the existing methods are poorly suited for supporting stakeholders to explore and evaluate alternative scenarios and facilitate (social) learning (e.g. Tschakert and Dietrich, 2010). New approaches are needed that can better enable high levels of uncertainty, multi-scaler complexity, and also enable structured reflection on both ecological and socio-political drivers of landscape change.

Serious gaming

An emerging and highly innovative participatory approach to learn about, discuss and explore the complexity of the various dimensions of complex contested landscapes has emerged and can be best described by the keyword "*serious gaming*". In multi-stakeholder settings, games function as (social) learning tools and boundary objects to discuss local voices and concerns. The aim of this method is to evaluate scenarios of improved management, through Scenario Evaluation Games (SEG). By active stakeholder

participation a joint sense of ownership of the evaluated scenarios is created which are expected to have a higher likelihood of implementation.

Serious games allow participants to explore system behaviour through scenario evaluation and to support negotiations in local contexts through *board games*, *computer simulation games* or the *combination of both* within the safety of the game environment (**Figure 2**). Playing games allows for a level of abstraction and experimentation that are not possible in most other participatory approaches. By abstracting problems from real-world settings, including the real world roles of participants, space is created for more creative and objective reflection on complex and often highly politicised problems. By capturing and reflecting on information related to these problems participants are more able to speculate on both the drivers of complex political problems and what are often highly contested solutions (Villamor and van Noordwijk, 2011; Villamor et al. 2014; Speelman et al., 2014; García-Barrios et al., 2008; 2017; Doddema et al. 2018).

Figure 2: Local community representatives in Uganda discussing the challenges with the introduction of oil palm in their landscape (*left*); Smallholder farmers in the South of Mexico, discussing territorial land use planning through the simple generic board game, RESORTES (*middle*); MSc students learning by exploring of complexity of landscape management through a computer simulation game (right). *Photos: EN Speelman*

But while the popularity of gaming is increasing, in the context of the management of complex landscapes the gaming approach itself is still in its infancy with large methodological questions remaining unanswered (Mayer et al. 2014; Speelman et al. 2018). Frameworks for the development and implementation and standardised analyses of gaming outcomes are yet to be developed (Speelman et al., 2018). For this field of gaming to mature, we need to move beyond single case studies applications and address major scientific challenges. These include: how to best assess, value and increase the impact of developed games; how to design games to reach a long-term impact; to which degree can locally successful games be transferred to other contexts to support landscape planning; how does the balance between place-based specificities and generic social political processes influence such a transferral.

Objectives

The overall objective of the SESAM programme is to develop interdisciplinary participatory **Scenario Evaluation Games (SEG)** for supporting and enhancing social learning and action by actors involved in multi-level decision-making processes around the **forest-water-people nexus**, and understand their impact on participatory decision-making on **water** and **(agro)forest landscape management**.

In addressing this overall goal, a series of short-term and long-term objective will be met. The short-term objectives of SESAM (realised in the time of the project) are to:

1. **Understand** the relevance and interplay of the three co-existing paradigms within the Forest-Water-People Nexus at various levels of landscape governance
2. **Develop** a framework for smart game design, game use and a toolbox for game analysis
3. **Support** and enhance the learning of actors within the Forest-Water-People Nexus in the case study areas

4. **Develop** a portfolio of SEG with track record developed and implemented in diverse social-ecological systems within tropical (agro)forested landscapes
5. **Assess** the relation between the type of game i.e. generic, site-specific, co-designed or standard, and the learning effect game session participants experience.

By realising these short term objectives the SESAM project will contribute to the following long-term objectives:

6. **Improvement** of participatory decision-making processes related to the Forest-Water-People Nexus within (agro)forest landscapes
7. **Upscaling** SEG use in tropical (agro)forested landscapes and other complex multi-scale resource use settings
8. **Development** of a global network of policy and science actors that professionalises the field of serious gaming

Conceptual framework

Serious games can be used as *boundary objects* in multi-actor decision-making processes linking *research* and *action* (**Figure 3**). This action research approach facilitates learning through interactive sessions mediated by serious games (see Barreteau et al., 2003). The approach encompasses various learning processes including: *single-loop learning* (acquiring knowledge for problem solving; Argyris, 1976)*, double- loop learning* (reflecting one's assumptions; Argyris, 1976) and *third loop learning* (transforming contextual setting; Nielsen, 1993; Swieringa and Wierdsma, 1992), *experimental-learning* (learning through experience; Kolb, 1984), and *social learning* (learning by observing and interacting with others; Bandura, 1977; Reed at al., 2010). In the field of serious gaming, all these learning process aim at triggering so-called *forward-looking* or *anticipatory-learning* (Tschakert and Dietrich, 2010). While most forms of learning primarily look at the past, anticipatory-learning explicitly focuses on the future and aims to strengthen one's ability to anticipate change and respond appropriately.

Interactive serious games and **simulation** facilitate participants to learn to anticipate change (=*anticipatory-learning*) through strengthening their understanding of the complex dynamics of tropical (agro) forested landscapes (=*single-loop-learning*) and by interacting with peers (=*social-learning*). By exploring responses to change (=*experiential-learning*) within the game, initial perceptions will be reframed (=*double-loop-learning*). The interaction with peers will stimulate discussion, thereby questioning and ultimately improving the context in which decisions are made (=*triple-loop-learning*).

Smart game design and *smart game use* are instrumental in learning about the *Forest-Water-People* nexus through gaming. By exploring the specifics of the connection among the three interacting concepts i.e. forest, water and people, in a variety of social-ecological contexts with actors from various governance levels will facilitate a deeper understanding of the novel concept of *Forest-Water-People* nexus (**Figure 3**).

The specific local contexts of the social-ecological systems that the game participants are part of shape all the elements of *Smart game design*, *Game use* and the *Forest-Water-People nexus*. By developing smart games that are sensitive to contextual knowledge, values and power relations among participants, serious games will allow and stimulate equal participation and decision-making power among stakeholders while creating learning opportunities taking into account and groups, rituals, affiliation and status of actors (Hofstede, 2015).

Relevance of the programme for SDGs

Our programme contributes directly to the sustainable management of water (SDG 6) and (agro)forests (SDG 15). The further development of Scenario Evaluation Games (SEG) will contribute to creating learning opportunities for a variety of stakeholders (SDG 4), aiming for equal participation and decision-making power among stakeholders (SDG 10). The later contribution is very significant as tools that facilitate communication among stakeholders are needed to achieve many of the SDGs.

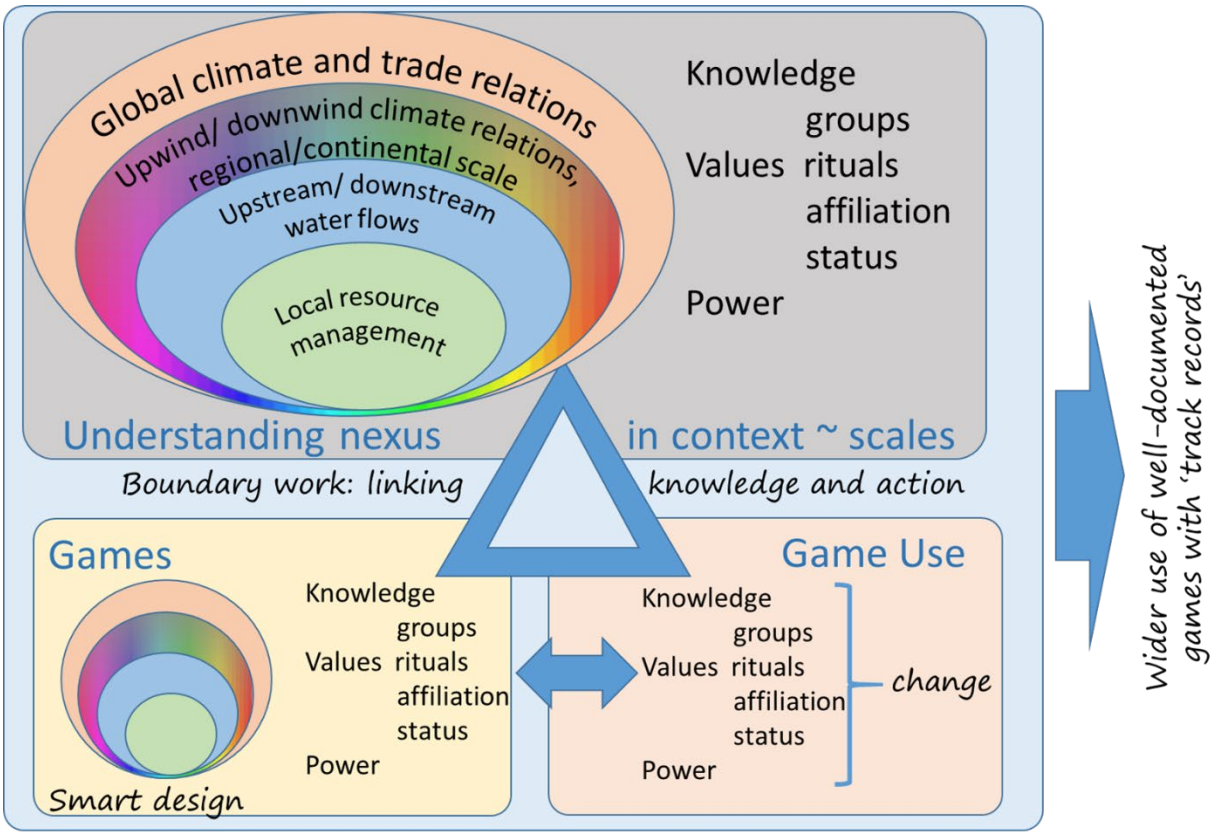

Figure 3: Conceptual framework of how *smart game design*, *game use* and *understanding or the Forest-Water-People nexus* are linked.

Research activities

The programme consists of **17 subprojects** i.e. **2 postdoctoral projects** (PD projects) and **15 PhD projects** (**Table 1**; see **Annex** *for individual PD and PhD project descriptions*).

The 15 PhD projects will perform independent research in distinct case study landscapes located on different positions on the forest transition curve. All PhD project are intrinsically interdisciplinary following the *Forest-Water-People* nexus focus of the program. However, the research emphases per PhD project might differ with some more focused on the Forest-Water interaction, while others might focus more on the Water-People components within the larger nexus (**Table 1**). Each PhD project will host at least 2 MSc thesis students from WU and local universities, resulting in a total of 30 SESAM MSc theses.

The two PD projects last both 1,5 years, while all PhD projects last 4 years. The aim of the first PD project is to develop a *framework* for smart game design and a *toolbox* of for game assessment. These tools will guide the game development and implementation in each of the PhD projects. The second PD project will start towards the end of the project and will perform a comparative analysis drawing lessons from the individual PhD projects. While both PD projects will also assist in day-to-day programme management.

Table 1: Overview of all postdoc (PD) and PhD projects in the SESAM programme including title, and the collaboration of WU chair groups and local University partners (*in italic*) in supervision and adviser.

ID	PhD or PD	Title	Location	Supervisor / Co-supervisors	Advisor
PD-1	PD	Methodological improvements in the field of serious gaming for sustainable development in	Wageningen	GRS,INF,PPS	-

		complex social-ecological systems			
PD-2	PD	Serious gaming for sustainable development in complex social-ecological systems; Lessons drawn from a comparative analysis of 15 case studies from the SESAM project	Wageningen	GRS,INF,PPS	-
PhD-1 IND-i	PhD	Cacao and Coffee Agroforestry on Hillslopes: Agroecology and Farmer Management Options	Indonesia	PPS PPS,*UB, TBI*	-
PhD-2 IND-ii	PhD	A collective strategy for sustain-able peatland restoration in Indonesia: scenario games	Indonesia	FEM HWM,*IPB*	GRS PPS
PhD-3 IND-iii	PhD	Multi Contested Actors for Securing Access over Water Resources of Singkarak Lake: A hydrological Approach in Socio-Economic Contexts	Indonesia	WRM GRS, *IPB*	GRS
PhD-4 IND-iv	PhD	Better management on complex natural resources: Gaming and Modelling on Pine Based Agroforestry System in Volcanic Mountainous Landscapes	Indonesia	FEM GRS, *UB*	PPS
PhD-5 KEN-i	PhD	Competing demands in the water towers of Kenya: Exploring multi-level dynamics through serious games	Kenya	HWM WRM, GRS, *JKU*	GRS
PhD-6 KEN-ii	PhD	Exploring Multi-level governance in contested landscapes; the case of Mt Elbon Uganda	Kenya	WRM GRS, *JKU*	GRS
PhD-7 SUR-i	PhD	Exploring forest ecosystem services though participatory games	Suriname	GRS HWM, AdeKUS, TBS	GRS
PhD-8 SUR-ii	PhD	Improving inclusive management of mangrove systems in Suriname	Suriname	ENP GRS, AdeKUS	GRS
PhD-9 PER-i	PhD	Exploring the role or multi-functional mosaic landscapes in view of increasing demands for quinoa production; a participatory gaming approach	Peru	GRS GRS, CIRAD	PPS
PhD-10 ECU-i	PhD	Land use dynamics and forest transformations in a biodiverse tropical montane landscape	Ecuador	HWM WRM, *FLACSO*	GRS
PhD-11 BRA-i	PhD	The future of trees in the Brazillian Cerrado; Awareness and dialogue through participatory gaming	Brazil	ENP FEM, *UniB*	GRS
PhD-12 BRA-ii	PhD	Serious games for multi-scalar awareness, dialogue and action in the Brazilian Amazon	Brazil	ENP FEM, *UniB*	GRS
PhD-13 BRA-iii	PhD	Gaming for forest restoration: participatory explorations through scenario evaluation games	Brazil	FEM PPS, GRS	*UniB*

PhD-14 GLO-i	PhD	The stakes in the global level; gaming and Agent-Based Modelling to explore the role of states and international actors	Global	INF ENP,GRS	GRS
PhD-15 GLO-ii	PhD	Gaming and Agent-Based Modelling for improved management of complex natural resource systems: the role of local actors	Global	INF PPS,GRS	GRS

Expected results, outcomes and end-users

We expect the following results and outcomes from the project:

- At least **64 publications** (four per PhD candidate and 2 per PD project)
- 15 **PhD theses** completed and defended
- 30 **Master theses** completed and defended
- At least 15 **Scenario Evaluation Games** developed, tested and implemented in the three landscapes
- A **PhD training** for the 15 PhD candidates to get knowledgeable of and skilled in the SEG development, implementation and analyses.
- **SEG training** material and University modules in the form of knowledge **clips** developed to be included in the curriculum of all academic partners involved in the project
- **Training workshops** developed and executed to train local partners to use SEG
- An **international final conference** of academics and practitioners from the field of scenario evaluation and gaming

End-users on the short-term: the first set of envisioned end-users of the tools and developed methodology within the programme will be the *academic* and *non-academic partners* of the program. The *portfolio of games* that will be developed *in* and *for* a wide range of systems, will provide boundary objects at every decision making level in tropical (agro)forested landscapes to facilitate social learning among stakeholders in each of the SESAM case study areas. In addition, with the program's end-products becoming available during the course of the program, a larger group of *potential end-users* that were not directly participating in the programme will be reached through the **programme website.** On the website developed games will be made available including track record and tutorials as the programme develops. In addition, knowledge clips will be developed and made publically available potentially reaching a wide range of end-users interested in the development and implementation of games.

End-users on the long-term: the envisioned end-users of the programme as a whole include the extended network of programme partners and collaborators, meaning an associated projects of the collaborators that were not used as case studies in the SESAM project. Through the methodological contributions to "maturing" the field of gaming both in the academic world as in the world of practitioners envisioned by the SESAM programme, all actors within the field of gaming field at large will be potential end-user of the SESAM program. To ensure the continued access to the output of the SESAM program, we will maintain and further develop the programme website by creating a "library" for serious games in the field of complex (agro)forestry landscapes (similar as to what is currently done by the agent-based modelling network (www.comses.net website).

Location of the programme

The SESAM programme is based on 2 PD and 15 PhD projects. Thirteen of the 15 PhD projects are independent interdisciplinary case studies (**Table 1**; **Annex IV**) exploring distinct social and ecological land use change related to the *Forest-Water-People* nexus along the forest-transition curve (**Figure 4**). These case studies are also spread across a seven

countries namely Indonesia, Kenya, Uganda, Suriname, Ecuador, Peru, and Brazil, representing a diversity of distinct socio-cultural and political economic drivers of forest and water exploitation. While generating knowledge on the context specific dimensions of the *Forest-Water-People* nexus in these countries, the cases also provide a basis on which to compare and generalise understanding, awareness and action of participants generated through serious gaming.

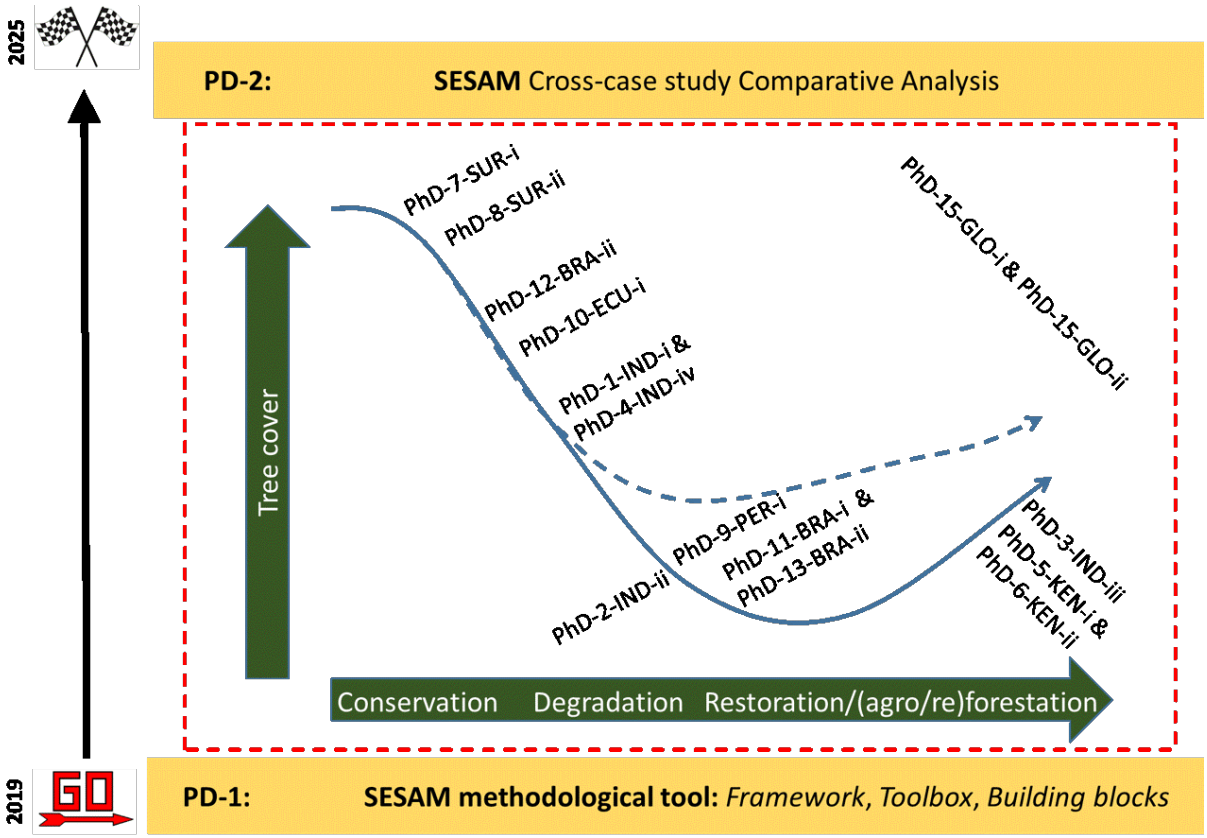

Figure 4: Overview of the rough position of the case study areas (*shown by project ID*; **see Table 1**; **Annex IV**) on the forest transition curve.

The selection of the countries in which case studies are located has been made in close collaboration with a global network of partners. Each of the countries involved provide a specific and contrasting set of challenges within the *Forest-Water-People* nexus influenced by their location on the forest transition curve (**Figure 4**). Along this curve is a high diversity of forests in different biomes, ranging from tropical rainforest (Brazil, Indonesia), savannah (Brazil, Kenya, Uganda), montane agro-forest landscapes (Peru and Ecuador, Indonesia) and coastal mangrove forests (Suriname). The countries and cases also represent different social and political contexts, ranging from globally contested agro-industrial use of forest land (Brazil, Indonesia, Ecuador, Peru), to conservation and biodiversity driven landscape classification (Ecuador, Brazil, Peru) to locally contested poverty and livelihood-based use of forest and water (Kenya, Suriname, Uganda).

Two of the 15 PhDs will focus on case studies of global processes and global issues related to landscape planning and management of tropical (agro) forested landscapes (**Figure 4**). These global case studies will explore the application of serious gaming across in two dimensions: first, by abstracting the context specific games and into a generic agent-based model, and second, by developing and playing a serious game with global decision makers (located in international fora and organisations like the United Nations, World Bank, and private companies).

4. Methods and approaches

The SESAM programme is based on a **case study approach** using a modular structure in which case studies are independent from each other, while at the same time coordinated in a way that cross cutting knowledge can be synthesised. Using both inductive and deductive research methods, hypotheses on patterns and trends in the dynamics of the *Forest-Water-People* nexus will be explored and tested through serious games. In addition, a cross-case study comparative analysis by the PD will allow us to answer currently large methodological challenges in the field of serious gaming.

The balance between the in-depth individual PhD research paths and the need for a rigorous sample to allow for a grounded cross-case study comparison will be developed through three key methodological components: First, a **process-based framework** that will organise the process of smart game design and, in addition, enable the role and results of games to be clearly communicated and transferrable to other contexts. Second, a **toolbox of analytical methods** to guide the development of analytic assessment tools for gaming analysis. This toolbox will comprise existing and new tools and methods, e.g. Q-method, an opinion assessment method (Watts and Stenner, 2005; Zabala et al. 2017) are currently being explored in the context of game impact assessment and show interesting results (Speelman in progress; Langston et al., 2019). Another potentially interesting assessment method is called Fuzzy Cognitive Mapping (Vanwindekens et al. 2014). Through fuzzy cognitive mapping the systems understanding of actors can be explored. The framework proposed by van Noordwijk (2017) could also be highly relevant in this context as a way to assess stakeholder understanding, perception, and willingness to act and adopt improved management options. Third, **methodological building blocks** for guiding and ultimately allowing comparison between the PhD projects. These building blocks are (1) Extensive baseline study of the complexity of the multi-level ecological and social dimensions of forest-water interaction (2) Game development, and game implementation (3) Game analysis assessing changes learning through changes in knowledge and perceptions.

Comparative analysis

Using the three methodological components developed in PD-1, all 15 PhD projects will be used to draw conclusions on: (1) the *Forest-Water-People* nexus and it dynamics in the specific socio-cultural context of the case studies, and (2) smart game design (developed by PD-1), and (3) the *impact of gaming on learning* on participants. The programme aims to be able to draw grounded conclusions on the relevance and interplay of at the core of the *Forest-Water-People Nexus*. Through a cross-case study comparative analysis, we aim to identify how different interpretations of forest-water interaction influence the understanding, awareness and action related to landscape change and management at different levels of governance (**Figure 5a**) in different locations on the forest transition curve.

The comparative analysis of games and their impact on actor learning in different contexts will also provide insights into larger methodological questions contributing the wider application of serious games as a generic approach for decision making under high levels of complexity and uncertainty. The portfolio of games developed within the SESAM programme will enable a more in depth understanding of (1) The relative value of *simple vs complex* and *co-designed vs. off-the-shelf* game design and, (2) a broad assessment of learning effects (through before and after comparison) of game session participants who enter with different levels of knowledge (**Figure 5b**). Through a classification of games and by assessing the relative learning impact of gaming participants experienced, learning from different game sessions with different games in different places in the world become comparable. As such, trends and patterns in the learning effects of specific types of games can be analysed. Based on this, recommendations to facilitate a wider use of well-documented games with track record and other serious games in general will be developed.

Interaction with non-research stakeholders

Stakeholder participation has a **central role** in the SESAM program. The main methodology developed and implemented "**Scenarios evaluation games**" is based on the participation of stakeholders, both research as well as non-research. The co-design of games is an

important aspect of game design in which the collective knowledge of stakeholders is key (Barreteau et al., 2003). The stakeholders in the various case studies will be actively involved in the development and the implementation of these serious games. From the start of the (pre)proposal writing, non-research stakeholders i.e. societal partners (see **section 7**; **Annex I**; **Annex IV**) have been actively participating in the development of project ideas.

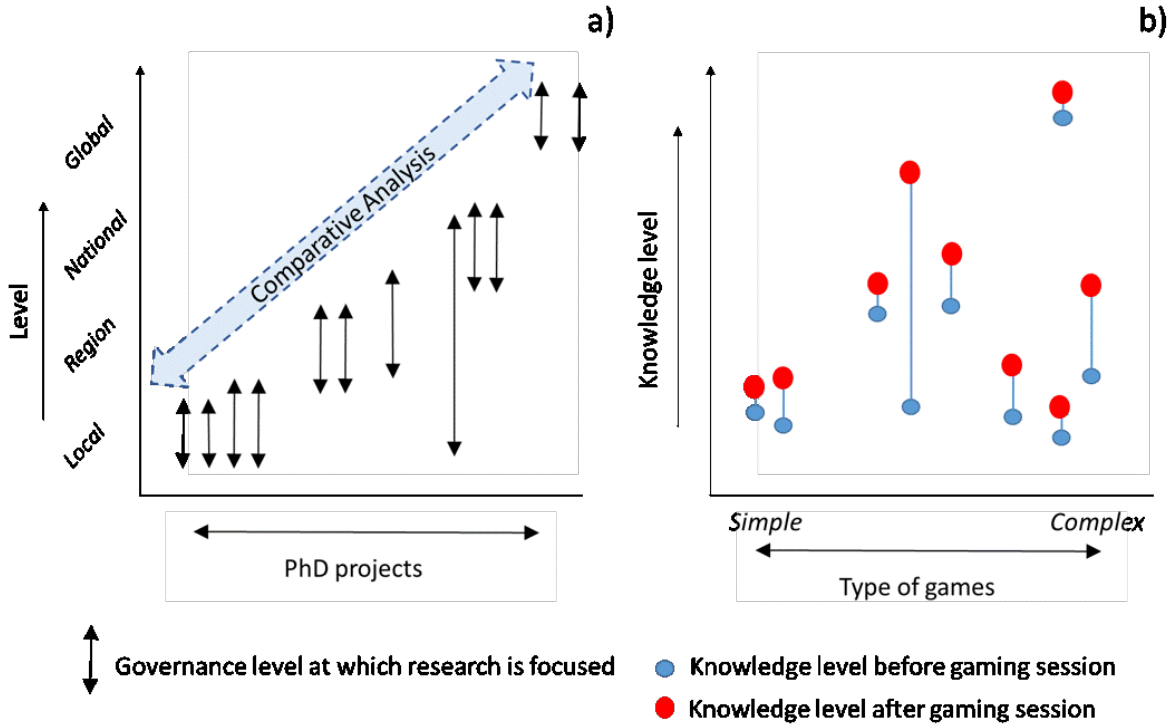

Figure 5: a) Schematic representation of the cross-case study comparative analysis, showing the diversity of the span of the individual case studies; b) Conceptual example of the expected insights om the relation between game type and the effect of the use of games on learning of gaming participants.

All PhD candidates will use an action research approach in their projects in which they work closely with (key)stakeholders. Through an **initial stakeholder assessment** (using *social network analysis*, stakeholders will be selected and actively involved in the development and implementation of the SEG through **interviews**, and **gaming workshops**. *Sharing SESAM results* and *discussing stakeholder feedback* is essential for contributing to *the realities of the local case studies* as well as to the achievement of the SDG. These activities will be emphasized in all individual case study areas as well as at the programme level. A **final international conference** will be organized to present and discuss the results of the programme to the wider public interested in serious gaming tools.

6. Time frame

The SESAM programme will officially start in **July 2019** and run over six years to **July 2025** (**Table 2**). The programme will start with the selection of PhD candidates for projects where no candidates have yet been identified. The first PD project also will start at this time. Eleven of 15 PhD candidates will start in **January 2020** with **4 PhD candidates** starting earlier as a result of already available funding. The second PD project will start towards the end of the programme to perform a comparative, cross-case study analysis. Ten milestone moments in which important deliverables were reached are planned throughout the program's duration.

Table 2: Planning of the SESAM programme including PD and PhD projects and programme milestones i.e. M1-M10.

		2019				2020				2021				2022				2023				2024				2025	
Project		**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**
1	P-1																										
2	PD-2																										
3	PhD-1-IND-i																										
4	PhD-2-IND-ii																										
5	PhD-3-IND-iii																										
6	PhD-4-IND-iv																										
7	PhD-5-KEN-i																										
8	PhD-6-KEN-ii																										
9	PhD-7-SUR-i																										
10	PhD-8-SUR-ii																										
11	PhD-9-PER-i																										
12	PhD-10-ECU-i																										
13	PhD-11-BRA-i																										
14	PhD-12-BRA-ii																										
15	PhD-13-BRA-iii																										
16	PhD-14-GLO-i																										
17	PhD-15-GLO-ii																										

M1: Start SESAM
M2: All PhD research started
M3: SESAM tools developed
M4: First game session held
M5: First article published
M56: Last game developed
M7: First PhD thesis defended
M8: Last PhD defended
M9: Comparitive analysis finalised
M10: Final conference

7. Partnership

The SESAM programme is developed **close collaboration** with a variety of partners, including Universities, research organisation and civil society organisations (**Table 3**). The first ideas for this programme came from discussions with some of the collaborating partners. The **active exchange** of ideas and research interests of all SESAM consortium members (**Figure 6**) during the development of the full proposal, resulted in the current programme proposal. During a **three-day workshop** in Wageningen (*16-18 January 2019*) in which most of the partners participated including partners from Indonesia, Kenya, and Suriname, a strong foundation for the SESAM programme was laid by in depth interactions among consortium members.

The SESAM consortium is composed of **6 Universities**, **5 research organisations** and **6 civil society organisations**, all who have confirmed their **interest** and **support** for this innovative programme (**Annex I and II**). This **interdisciplinary consortium** will collaborates in the facilitating, guiding and supervising the research performed by the PD and PhD candidates.

The collaboration with **Universities** in each of the case study countries is **essential** for the success of the individual PhD research projects. The **(scientific) knowledge** of local systems in each of the case study areas will be key in exploring the complex (agro) forest landscapes while the network with local communities, research organisations and civil society will facilitate the research of the PhD candidates. At a programme level, these connections with local universities will stimulate more and stronger **knowledge exchange** and **collective knowledge development**.

The SESAM programme has already build several important relations with global research organisations like the **World Agroforestry Centre (ICRAF)** and the French agency for international cooperation and sustainable development of tropical ad Mediterranean regions development (**CIRAD**), and large civil society organisations **Tropenbos** and **World Wildlife Fund (WWF**) of which the latter two have shown a continuous interest over the last few years in the topic of gaming and the experience of the consortium members.

Building and fostering these partner relationships are of strategic importance for Wageningen university to contribute to "*science for impact*".

Table 3: Overview of the International partner organisations categorised as: Universities, Research organisations, and Civil society organisations.

International partner organisations	Contact person	Country
Universities		
University of Brasilia (UnB)	Dr. Mercedes Bustamante	Brazil
Universitas Brawijaya (UB)	Dr. Didik Suprayogo	Indonesia
IPB University	Dr. Soeryo Adiwibowo	Indonesia
Jomo Kenyatta University of Agriculture and Technology (JKUAT)	Dr. John M. Gathenya	Kenia
The Anton de Kom University of Suriname (AdeKUS)	Dr. Riad Nurmohamed	Suriname
Research organisations		
National Institute for Space Research (INPE)	Dr. Jean Ometto	Brazil
World Agroforestry Centre (ICRAF)	Prof.Dr. Meine van Noordwijk	Indonesia
World Agroforestry Centre (ICRAF)	Dr Catherine Muthuri	Kenia
World Agroforestry Centre (ICRAF)	Dr. Andrew Miccolis	Brazil
CIRAD - Agricultural Research Centre for International Development	Dr. Didier Bazile	
Civil Society Organisations		
Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN)	MSc. Manuel Peralvo	Ecuador & Peru
Tropenbos International	Dr. Roderick Zagt	The Netherlands
Tropenbos Indonesia	Dr Edi Purwanto	Indonesia
Tropenbos Suriname	Dr. Rudi van Kanten	Suriname
WWF - Brazil	Carolina Siqueira MSc	Brazil
WNF – the Netherlands	Sarah Doornbos MSc	Netherlands

8. Organisation and management of the programme

The general organisation and management of SESAM will be coordinated by the programme's **Daily Board,** consisting of the principle investigator (PI) (Prof. Gert Jan Hofstede) and the two **co-PIs** (Dr. Ir Erika N Speelman and Prof.dr. Meine van Noordwijk). The Daily Board will be responsible for the development of the common research framework, organising specific trainings for the PhD students, organising the annual meetings, and the financial management and reporting to INREF and other funders. In addition, **Dr. Speelman** will be actively involved in all PD and PhD projects throughout the programme 6 years-lifetime, as the objectives of the SESAM project embody her *personal tenure track ambitions*. Throughout the program, she will be affiliated to all PhD projects as co-supervisor or advisor and be working together with the PD (PD-1 and PD-2) on developing SESAM tools (PD-1) and the cross-case study comparative analysis (PD-2). Her involvement in all projects will guide the establishment of a grounded sample for the final cross-case study comparative analysis.

Strategic decisions on funding, programme decision and science for impact will be made through the **SESAM programme committee,** consisting of the programme leader (PI), the two co-programme leaders (co-PIs) and **five country** or **region representatives** (one each for Indonesia (4 PhDs), Kenya (2 PhDs), Suriname (2PhDs), the Andes (Ecuador, Peru – 2 PhDs) and Brazil (3 PhDs). The programme committee will have regular (skype) meetings once every 3 months.

The Wageningen scientific staff involved in SESAM will collectively form an **interdisciplinary advisory board**, providing ad hoc advice to the daily board and programme committee on decisions relating integration, publication, integrity and methodology. They will formally meet once a year to contribute to the strategic programme decisions at the annual meeting.

Finally, an **international advisory board** consisting of **6 key members** of the gaming field (see *Annex* for their letters of support) will advise the programme committee by providing feedback on the programme design at the kick off meeting, PhD proposals and the programmes annual report's. They will also attend the programmes annual meetings. The 6 members together represent: i) the scientific world - *Dr. Luis García-Barrios, Mexico*, ii) practitioners – *Cora van Oosten*, *MSc the Netherlands*, iii) relevant professional networks i.e. Companion Modelling (ComMod) - *Dr. Christophe Lepage, France*, gaming network (SAGANET) - *Herman van der Bij MSc*, *the Netherlands,* social simulation (ESSA) - *Dr Gary Pohill, UK*, and iv) Gaming business - *Dr. Claude Garcia, Switzerland*.

The Wageningen scientific staff (promotors and co-promotors) and staff from the partner institutes (local supervisors) will coordinate the **daily supervision** of the PhD. The local supervisors of the PhD's are responsible for securing the working conditions, ensuring progress of the PhD research process, and identifying and resolving everyday challenges. They report to the programme committee about the progress of the PhD candidates.

Annual meetings with **workshops** ensure integration of the various cases during the course of the program. Except for the kick-off meeting and final conference (which will be held in Wageningen), these meetings will be held in one of the research sites. Interactive workshops will provide a safe and stimulating environment for the PhD's to present their work and receive feedback from both involved researchers and fellow PhD's. The workshops will include field visits, and reserve sufficient time for informal interaction between students and supervisors.

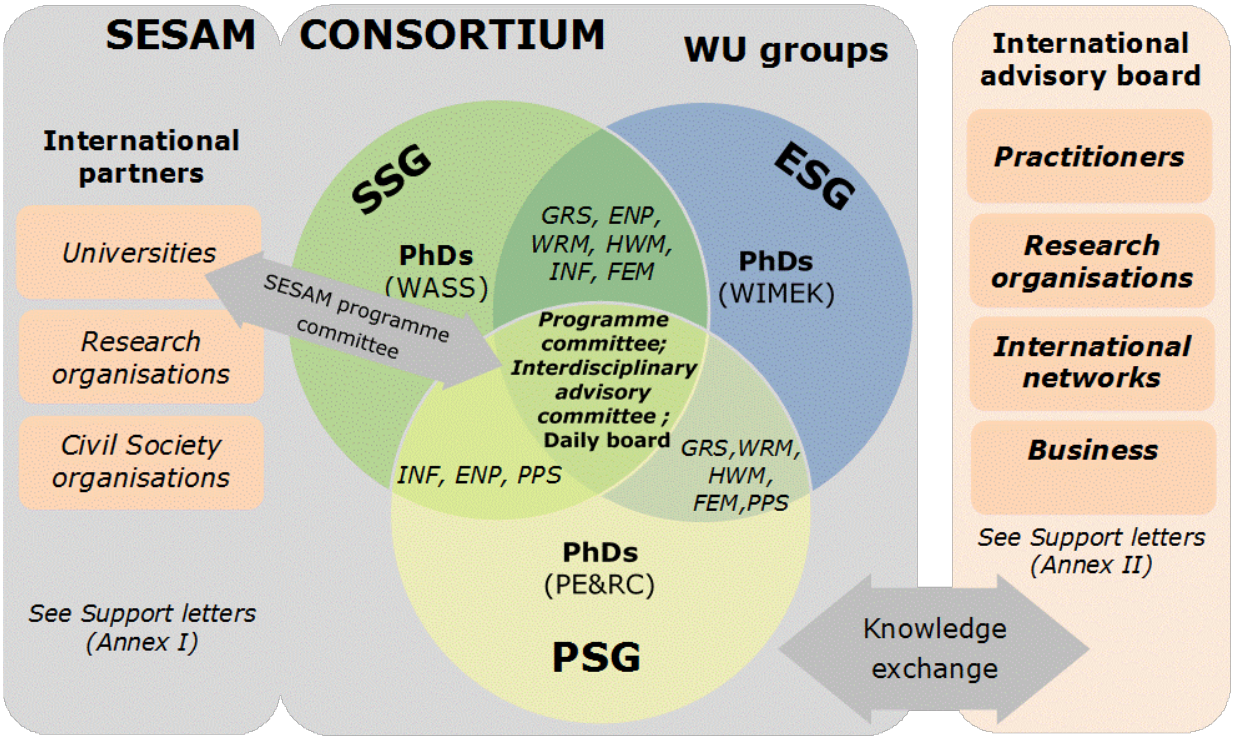

Figure 6: Structural overview of the SESAM consortium in which WU graduate schools, Science groups and chair groups collaborate closely with International partners. The international advisory board is composed of key representatives from the gaming world and will advise the program.

9. Budget

The proposed overall budget for the SESAM programme is **M € 2.16** of which a total of **€1.195.492,-** is requested from INREF, while **€ 969.500,-** is raised through **co-funding** (**Table 3;** see **Annex VII** for further details on the budget). Co-funding commitments with partners are stated in the *letters of intent* and/or *intent* (**Annex I**).

Further and additional discussions and negotiations for **securing additional funding** are ongoing with (several) potential partners e.g. World Wildlife Fund (WWF) in the Netherlands and in Brazil, The World Agroforestry Centre (ICRAF), International Union for Conservation of Nature (IUCN) and some of the academic partners of the SESAM program.

Table 3: Overview of the proposed budget for the SESAM programme.

OVERALL OVERVIEW

	YEAR	2019	2020	2021	2022	2023	2024	2025	TOTAL 2019-2025
300	PERSONNEL COSTS	32,560	63,015	13,683	14,093	61,560	39,817	0	224,727
500	OPERATIONAL COSTS/INVESTMENTS	0	2,500	0	84,000	0	0	0	86,500 0
600	PhD TRAINING/WORKSHOPS ETC.	0	206,141	184,500	184,500	262,125	47,000	0	884,265 0
	GRAND TOTAL BUDGET	32,560	271,655	198,183	282,593	323,684	86,817	0	1,195,492

DETAILED COST PER CATEGORY

300	PERSONNEL COSTS	2019	2020	2021	2022	2023	2024	2025	
	Postdoc	17,296	36,567	0	0	34,591	18,283	0	106,736
	Indirect costs	6,226	13,164	0	0	12,453	6,582	0	38,425
	TOTAL COSTS POST-DOC	23,522	49,730	0	0	47,044	24,865	0	145,161
	Overall project coordinator	2,837	5,845	6,020	6,201	6,387	6,578		33,868
	Indirect costs	1,021	2,104	2,167	2,232	2,299	2,368		12,192
	Admin/financial coordinator	3,809	3,923	4,041	4,162	4,287	4,415		24,637
	Indirect costs	1,371	1,412	1,455	1,498	1,543	1,590		8,869
	TOTAL PROJECT-RELATED	9,039	13,284	13,683	14,093	14,516	14,951	0	79,566

500	OPERATIONAL COSTS	2019	2020	2021	2022	2023	2024	2025	
	TOTAL OPERATIONAL COSTS		2500	0	84000	0	0	0	86,500

600	PhD Sandwich (Not employed with WU)	PhD 2 - Indonesia PhD 2 Brazil	PhD 1 - Surinam	PhD 2 - Suriname	PhD 1 - Peru			
	SUBTOTAL FELLOWS in NL	0	41,200	52,500	52,500	67,900	0	0	214,100

600	PhD Labour (WU employed)	PhD 3 - Indonesia	PhD 1 - Kenya	PhD 1 Brazil	PhD 2 Global			
	SUBTOTAL FELLOWS in NL	0	143,441	40,000	40,000	170,225	0	0	393,665

600	PROJECT-RELATED ACTIVITIES	2019	2020	2021	2022	2023	2024	2025	
	TOTAL COURSES / ACTIVITIES	0	21,500	92,000	92,000	24,000	47,000	0	276,500

Co-funding	2019	2020	2021	2022	2023	2024	2025	
TOTAL								969,500

10. WU- Senior Staff/Researchers involved in the programme

The SESAM programme will foster new and strengthen existing alliances between the Social sciences, Environmental Sciences and Plant Sciences Groups and across PE&RC, WASS and WIMEK research schools at Wageningen University (**Table 4**). The consortium builds on **strong past collaborations** through joint projects and publications, which will warrant both scientific innovativeness as well as sound embedding of the project into local, national and international contexts. The SESAM WU-team combines both s. The team brings together expertise on *sustainable forest management* (e.g. Dung et al., 2013; KimDung et al. 2016; Lahsen, 2016), *landscape approaches* (Salvini et al 2016), *global environmental governance and politics* (Lahsen 2005; Lahsen et al. 2015; Bush 2018), *social behavioural theory (Hofstede 2017)*, *agroforestry systems*, *forest-water relations* (Teuling et al., 2017), *sustainable watershed management* (van Oel et al., 2018), *scenario evaluation games* (Speelman et al., 2014), *computer simulations* (Speelman and García-Barrios, 2010;

Ligtenberg et al., 2010; Van Oel et al., 2018), *complex multi-stakeholder processes* (Teixeira et al., 2018) and *social learning* (García-Barrios et al., 2008).

WU coordinators

- **Prof.dr.ir. Gert Jan Hofstede** (**PI**), Personal professor Information Technology Group (INF); a pioneer in modelling sociality using theory e.g. cross-cultural social psychology, sociology; PI on several large projects on complexity e.g. (SEMIRA; 4TU projects); founder of SiLiCo; (co)-supervisor: 20 PhDs In SESAM: PI, (co)supervisor, gertjan.hofstede@wur.nl
- **Prof.dr. Meine van Noordwijk** (**co-PI**), Special Professor Agro-forestry, Plant Production Systems (PPS), Former head of ICRAF South-East Asia; Expert on agro-forestry systems in tropical regions; PI on many large project, member and chair of many global fora; In SESAM: co-PI, (co) supervisor, meine.vanNoordwijk@wur.nl
- **Dr.ir. Erika N. Speelman** (**co-PI**; **contact person** Geo-Information Science (GRS); Expert on gaming and simulation, agent-based modelling, contested agricultural landscapes; manages several smaller project; organised several summer schools and workshops on gaming and simulation. Co-supervisor: 3 PhD candidates, 15 MSc students. In SESAM: co-PI, co-supervisor, advisor, postdoc, erika.speelman@wur.nl

WU scientific staff

Prof. Dr. Simon Bush, Chair of Environmental Policy Group (ENP); Expert in environmental and natural resource governance, with a focus on the fisheries and forestry; former PI of INREF BESTTuna programme; INREF RESCOPAR programme; He is currently leading and involved in a number of NWO programmes, and is currently the promotor of 11 PhDs. In SESAM: PhD supervisor, simon.bush@wur.nl

Dr. Myanna Lahsen, Environmental Policy Group (ENP); Expert on knowledge challenges associated with climate change and transformations to sustainability in the USA and Brazil, including the Brazilian Cerrado. PI on several US National Science Foundation funded projects, several Brazilian project; supervisor of 4 PhD candidates, many BSc and MSc and students. In SESAM: PhD co-supervisor, myanna.lahsen@wur.nl

Prof. Dr. Devis Tuia, Chair of Geo-Information Science (GRS); Expert in GIS, remote sensing, machine learning, active learning; Project leader of several medium (300k-500k Euros) and large (1.5M euros) personal grant, Supervisor of 10 PhD candidates, 18 MSc thesis, In SESAM: PhD (co)supervisor, devis.tuia@wur.nl

Prof. Dr. Martin Herold, Chair of Remote Sensing (GRS); Expert in remote sensing, RED++, forest monitoring; Project leader of many large projects on forest monitoring and RED+; Supervisor of more than 30 PhD candidates, and more than 20 MSc thesis, In SESAM: PhD (co)supervisor, martin.herold@wur.nl

Dr. Ir. Arend Ligtenberg, Geo-Information Science (GRS); Expert in spatial-temporal process, complex adaptive systems, agent-based modelling; co-PI on various national and international projects. Supervisor of 5 PhD candidates, 50 Msc-students. In SESAM: PhD (co)supervisor. arend.ligtenber@wur.nl

Dr.ir. Pieter R. van Oel, Water Resources Management (WRM). Expert in socio-hydrology, sustainable water resources management; PI for NWO-WOTRO SDG project 3DDD (4 partners, Brazil); PI for WIMEK-LAKES project (postdoc supervision, Kenya) former co-coordinator of NWO-WOTRO IP project EOIA (Kenya; PhD supervision); Supervisor of 6 PhD candidates. In SESAM: PhD (co)supervisor, pieter.vanoel@wur.nl

Dr. Marielos. Peña-Claros, Forest Ecology and Management (FEM). Expert on the ecology and management of tropical (human-disturbed) forests; former co-coordinator of the INREF Terra Preta Program; Work package leader of the EU funded ROBIN project (12 partners). Supervisor of 11 PhD candidates (3 in INREF), 37 MSc thesis, 9 MSc internship and 10 BSc thesis. In SESAM: PhD (co)supervisor, marielos.penaclaros@wur.nl

Dr. Adriaan J. (Ryan) Teuling, Hydrology and Quantitative Water Management (HWM). Expert on climate hydrology and the role of forests in the water cycle; former NWO Veni laureate; Work package leader of NWO funded project SWM-Evap. (Co,)supervisor of 12 PhD students. In SESAM: PhD (co)supervisor, ryan.teuling@wur.nl

11. Related Programme(s) of Graduate School(s) concerned

The project matches with the various research themes of the research schools involved (**Table 5**). It combines the ecological and environmental research themes of PE&RC with the sustainable development and global change themes of WIMEK and the research on conflict, competition, and collaboration in natural resource management of WASS. Complex Adaptive Systems thinking is the common denominator in this programme. It allows for an innovative way of thinking to combine social learning, sharing of knowledge across social and spatial scales, and participatory decision-making with the state-of-the-art knowledge on ecological and social systems.

The project strongly builds on the knowledge, methods and tools developed within the successful **WU-IPOP project** "*Complex Adaptive Systems (**CAS**)*" and the ongoing **WU-INREF project** "*Nature's benefits in agro-forest frontiers: linking actor strategies, functional biodiversity and ecosystem services* (***FOREFRONT**)"*. In all three programs, some *serious gaming* and *simulation* tools have (partially) been explored in range of different social-ecological systems.

Table 5: Related programmes and research themes of the graduate schools involved.

C.T. de Wit Graduate School for Production Ecology and Resource Conservation (PE&RC)
• Bio-/geo-interactions and Biodiversity (*Research theme 2*) • Complex Adaptive Systems (*Research theme 3*) • Innovative Nature (*Research theme 4*)
Wageningen School of Social Science (WASS)
• Natural Resources and the Environment: Conflicts, Competition and Collaboration (*Research theme 3*) • Knowledge in Society: Contestation, Boundaries and Bridges (*Research theme 4*)
Wageningen Institute for Environment and Climate Research (WIMEK)
• Environmental change and ecosystem dynamics (*Research theme 2*) • Global and regional environmental change (*Research theme 3*) • Sustainable development and social change: actors, institutions and governance (*Research theme 4*) • Spatial analysis (*Research theme 5*)

12. Relation with WU education programme

The SESAM programme will include **MSc thesis** and **MSc internship** students from Wageningen University as well as from the collaborating Universities in Indonesia, Kenya, Uganda, Suriname, Ecuador and Brazil. To further increase *knowledge exchange* and *(social) learning* among MSc students, we will aim to match the planning of MSc thesis or MSc internship students in a way that a WU student and a student from one of the collaborating universities.

The SESAM team will develop a series of *knowledge clips* to introduce the research concepts, case study areas, research results as well as gaming tools developed during the SESAM program. In total five knowledge clips will be developed during the course of the program. The SESAM academic partners in the various case study countries have committed themselves to including research concept, methods and results in to several of their MSc courses. The SESAM team identified the following existing WU courses to include SESAM research:

BSc level:

- WRM21312 - Design in Land and Water Management 2

MSc level:

- ENP33306 - Environment and Development
- ENP38506 - Environmental Quality and Governance
- ENP39306 - Advanced International Environmental Governance *Involved students of the Sustainable Development Diplomacy track*

- FEM30306 - Forest Ecology and Forest Management
- GRS30306 - Spatial Modelling and Statistics
- HWM32806 - Catchment and climate hydrology
- INF50816 - Modelling and Simulation of Complex Socio-Technical systems
- WRM34306 - Water System Design for Water Use from Multiple Sources

PhD level:

- Post-graduate course on Companion Modelling: Facilitating multi-stakeholder processes – *Collaboration between ETH and WU, organised annually alternating between Zurich and Wageningen (Dr.Ir. Erika N Speelman)*

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Annexes full proposals

Annex I – Letters of support Partners
Annex II – Letters of support International Advisory board
Annex III – Information of Partners
Annex IV – Description of PD and PhD projects
Annex V – List of relevant publications from SESAM consortium
Annex VI – Budget
Annex VII – Logical Framework