PROTECTING AND RESTORING TROPICAL ECOSYSTEMS

Situation

- Climate change presents the single biggest threat to reaching the Sustainable Development Goals (SDG's) - **urgent action critical to mitigate climate is quintessential to successfully achieving all SDG's**
- The food and land use system in general and **tropical ecosystems** in particular **play a key role in global climate change** – forests and peatlands in countries such as Indonesia both contribute but also mitigate global climate change.
- As of today, **Indonesia is the world's fifth largest emitter of greenhouse gases**, mainly due to the conversion of its forests and carbon-rich peatlands, not only affecting the climate but also threatening biodiversity
- A set of **technologies can play a key role to support required transitions** to protect and restore tropical ecosystems:
- Technologies **making supply chains transparent and traceable** contribute to **protecting tropical forests by creating a market for agroforestry products**, providing communities with an economically attractive alternative to slash-and-burn agriculture practices.
- Aggregating **geospatial vegetation data** and integrating those into local systems provide the **basis for actionable reforestation** projects with high success probabilities at scale.
- Specifically, **peatland restoration requires novel remote-sensing approaches** enabling **assessing the effectiveness of interventions** such as revegetation, re-wetting and canal blocking at feasible cost levels
- Finally, the precise, low-cost and fast **measurement of CO2e sequestration potential** across types and conditions of areas would deliver the necessary granular information basis for a transparent **ecosystem services market** incentivizing and compensating stakeholders for protecting and restoring natural ecosystems

Tech challenges *(specified in the following)*

1

Creating an agroforestry market platform enabled through supply chain transparency

2

Identifying reforestation areas and guiding activities across agricultural areas, peatlands and degraded land

3

Peatland health and restoration monitoring and intervention effectiveness

4

Assessing and mapping CO2e sequestration potential across rainforests, peatlands, and agricultural areas

AHEAD Empowering Hightech Ventures

Source: SYSTEMIQ analysis

Fraunhofer VENTURE

#1: CREATING AN AGROFORESTRY MARKET PLATFORM ENABLED THROUGH SUPPLY CHAIN TRANSPARENCY


Source: Fairventures

What is your overall vision?

Greenhouse gas emissions from tropical deforestation exceed those of the European Union. As of 2018, 380 million hectares of primary forest – equivalent to around 20% of all remaining tropical forest – is under direct risk of deforestation due to being located within 5km of communities, agricultural areas and roads – also called forest frontier. Those tropical forest areas already exposed and vulnerable through recent human activity must be immediately and decisively protected as they are in the strategic position to protect the around 1.5 billion hectares of forest that lies behind the frontier. The overall vision is to protect and restore natural ecosystems in the tropical belt by creating interest-aligning income streams for smallholder farmers and their communities living in areas under high risk of deforestation. Such income streams include revenue from produce prospering in standing tropical forests and agroforestry practices (e.g. cocoa, coffee, distinct oil palm species) as well as naturally occurring produce (e.g. wild honey, Jelutong (natural latex) or cosmetics ingredients such as Jernang 'dragon blood' Illiple nut butter). Respective revenues are competing with slash-and-burn practices used to clear land for conventional agriculture such as mono-culture oil palm plantations, promising high yields and offtake at stable prices.

Exemplary SYSTEMIQ expertise and validation partners

- Food and Land Use Coalition
  The Food and Land Use Coalition
- SYSTEMIQ Indonesia Land Use Incubator
- SYSTEMIQ Sustainable Special Economic Zones (SSEZ) projects in Nigeria, Ethiopia & Kenya
- Partnership4Forests containing projects such as protecting standing forests by commercialising wild honey
  Partnerships for Forests

What customer problem are you trying to solve and why is this promising?

For that to be realized, **transparent supply chains need to be established, linking smallholder farmers and their communities to brands serving eco-conscious consumers who are willing to pay a premium for products supporting the preservation and restoration of tropical forest ecosystems**. Smallholder farmers and their communities lack access to agroforestry knowledge, respective seeds and the access to customers guaranteeing offtake at a price premium. National, regional and global brand owners want to establish and ensure environmentally friendly and ethically responsible supply chains, but lack transparent contact to communities that can provide the products/ ingredients demanded by eco-conscious consumers at the right quantity and quality. As a result, only small to medium projects of individual companies working with selected communities to supply one type of produce. Technologies are needed to scale such projects to a level living up to the challenge of protecting and restoring the tropical frontier forests.
We want to solve those by creating a scalable, tech-enabled platform A) identifying suitable communities, B) providing suitable communities with purchase commitments at a premium from a range of companies across a range of products, C) creating transparent supply chains and ensuring traceability by integrating supply chain partners into the platform and D) embedding the platform in local action by facilitating farmer and community education and the redistribution of learnings and feedback.

In which market/industry would you categorize your idea?

Agriculture, Consumer Products & Services, Mobile & Telecommunications, Information Management

Source: SYSTEMIQ analysis

#1: CREATING AN AGROFORESTRY MARKET PLATFORM ENABLED THROUGH SUPPLY CHAIN TRANSPARENCY


Source: Fairventures

Why Fraunhofer

- Supply chain and logistics knowledge at e.g. SCS and IML
- Image Analysis and Pattern Recognition at e.g. IIS, IOSB

What piece of technology are you lacking?

- **Spatial mapping and local data integration:** A) Data aggregation technologies combining existing satellite data (e.g. Global Forest Watch data base, GLAD – Global Land Analysis & Discovery, Google Earth Engine, Trends.Earth) to map tropical frontier forests under risk of deforestation, B) Initial ground and land title data to identify respective communities to be addressed, C) Embedding information of locally active players such as extension services of NGO's, D) Embedding data on suitable crops for agroforestry and potential products naturally occurring in respective standing forest
- **Optimizing demand and supply option space** created by A) Preferences, dynamics and seasonality of demand provided by partner companies and B) Yield forecast of potential communities, influenced e.g. by growing conditions
- **Supply chain analytics knowledge and technologies tailored to product specific needs that ensure transparency and traceability** – such as: A) online identification of smallholder farmers and respective spatial produce source, production capacity mapping, reconciliation of actual use with jurisdictional plans and satellite data C) Chain of custody and ledger technologies ensuring traceability of transactions throughout the supply chain linking the communities and brands, D) Supply chain mapping and analytics, risk assessment analysis and identification of supply chain separation potentials, E) Quality monitoring technologies, F) Integration of shared partner network (processing facilities, logistics, packaging) enabling tracking and management of middlemen

What is your R&D need and what do you expect Fraunhofer to deliver?

The key challenge is to combine above mentioned technologies at a sufficient level of automation and at low-cost, enabling participating brands to pay a fee on products handled over the platform that does not exceed the price premium consumers are willing to pay minus the premium claimed by the smallholder farmers/ communities.

In what of the suggested research field would you categorize your idea/problem to be solved?

computer and information sciences, biological sciences, information engineering, agriculture, forestry and fisheries, other agricultural sciences, supply chain analytics

Source: SYSTEMIQ analysis

#2: IDENTIFYING REFORESTATION AREAS AND GUIDING ACTIVITIES ACROSS AGRICULTURAL AREAS, PEATLANDS AND DEGRADED LAND


Source: Nanang Sujana/CIFOR

What is your overall vision?

Enabling reforestation initiatives and sustainable agricultural models is an essential part of required critical transitions within the food and land use system to limit global warming to a maximum of + 1.5 degrees Celsius. Significant reforestation across 800 million hectares (theoretically even 1.6 billion hectares when accounting for agricultural intensification) can be conducted. That potential translates to almost 8 additional gigatons of CO2e being removeable from the atmosphere annually by 2050 (33.1 gigatons CO2e emitted globally in 2018). Yet, looking at Indonesia, efforts to reforest degraded land, resulting from mining, logging and various agricultural activities, have fallen far short of the local targets. Transparent information about reforestation potentials is essential to guide projects, farmers and policy.

Exemplary SYSTEMIQ expertise and validation partners

- Food and Land Use Coalition
  The Food and Land Use Coalition
- Projects with reforestation/ agroforestry NGO's and social businesses
- Investment in scalable reforestation solutions such as BioCarbon Engineering

What customer problem are you trying to solve and why is this promising?

Key problems of several customer groups are addressed. In particular, local governments/policy require **tech-enabled transparency to identify areas suitable for reforestation projects** (i.e. mapping, land use monitoring and ground sensor measurements). This is needed to **guide respective decision making, incubate sustainable agricultural and entrepreneurial activities as well as to identify efficiency and cost improvements for reforestation activities**. For restoration projects, reliable data at low cost are required to assess success probabilities beforehand and to track progress in existing projects. Among others, this would allow for design of innovative programs that enable local farmers and communities to act on the reforestation potential through more productive and regenerative agroforestry practices (i.e. cultivation and use of trees in combination with crops and livestock in agricultural systems). For companies up the agricultural value chain, detailed information on the health of plantations is required to offer sustainable products (e.g. sustainable palm oil, timber for pulp&paper) – addressing raising demand of consumers for ecologically and ethically-friendly products.

In which market/industry would you categorize your idea?

Agriculture, Mobile & Telecommunications, Microelectronics, Information management

#2: IDENTIFYING REFORESTATION AREAS AND GUIDING ACTIVITIES ACROSS AGRICULTURAL AREAS, PEATLANDS AND DEGRADED LAND


Source: Nanang Sujana/CIFOR

Why Fraunhofer

- Aerial vegetation monitoring at e.g. IPM
- Ecological know-how at e.g. IME
- Image Analysis and Pattern Recognition at e.g. IIS, IOSB
- Environmental sensing at e.g. IPMS
- Sensor technologies at e.g. IPM

What piece of technology are you lacking?

1) Mapping & area identification: Data crawling/aggregation technologies integrating existing satellite data (e.g. Global Forest Watch data base, GLAD data – Global Land Analysis & Discovery, Google Earth Engine, Trends.Earth)
2) Mapping of geospatial vegetation parameters (e.g. building on digital terrain/surface models or forests/peatlands based existing data or images captured by aerial vehicles (e.g. LiDAR models)) to identify areas feasibly for reforestation or agroforestry
3) Continuous integration of land tenure rights and regulatory requirements
4) Fast and cost-effective ground sensor based and remote measurement of e.g. soil and water chemistry data and matching with revegetation options such as distinct crop and tree combination for agroforestry
5) Linkage to local reforestation project data and integration of potential innovative delivery partners such as BioCarbonEngineering
6) Tech-enabled remote sensing technology for monitoring of reforestation progress
7) Facilitating local ground action by creating a virtual platform and interface connecting interface to and from local partners such as governmental agencies, farmers and companies

What is your R&D need and what do you expect Fraunhofer to deliver?

Key challenge is to integrate cutting-edge data with granular vegetation monitoring/remote-sensing approaches and link it to actual/local reforestation opportunities (incl. respective actors/projects). Cost-reducing innovation is especially needed to bring the integrated technological solutions cost to a level making reforestation investible at current carbon prices.

In what of the suggested research field would you categorize your idea/problem to be solved?

Agriculture, environmental sciences, remote sensing, machine learning, computer vision, ecology, earth observation, biological sciences, civil engineering, electrical engineering, environmental biotechnology

#3: PEATLAND HEALTH AND RESTORATION MONITORING AND INTERVENTION EFFECTIVENESS


Source: DPA

What is your overall vision?

Protect peatlands and support peatland restoration initiatives is crucial due to peatlands being particularly carbon-intense in the sense of absorbing and storing large amounts of CO2 over a long time. The great fire peatland fires on Borneo and Sumatra in 2015 destroyed more than two million hectares of peatland forest, resulting in daily carbon emissions exceeding those of the US economy. Restoring peatland is expensive, difficult and contains interventions such as re-wetting through e.g. canal blocking, revegetation and village livelihood revitalization. Mapping technologies and monitoring infrastructure is needed not only for fire alert systems, but for assessing the effectiveness of restoration interventions and for deriving best practices. Such information creates transparent and actionable projects, linking it to local projects and therefore empowering communities. Establishing such a system successfully in Indonesia could be the basis for creating further impact in the peatlands of Brazil, the Democratic Repuplic of Congo and also drying peatlands in Europe at a later stage.

Exemplary SYSTEMIQ expertise and validation partners

- Food and Land Use Coalition
  The Food and Land Use Coalition
- SYSTEMIQ Indonesia Land Use Incubator
- Projects with among others the Indonesia Peatland Restoration Agency BRG
- SYSTEMIQ Geo Information Systems team in Indonesia

What customer problem are you trying to solve and why is this promising?

Peatland burning creates high concentrations of CO2, methane, CO, ammonia, acids, or particles in the air with apocalyptic scenes in one of the oldest and most diverse forests of the world. The government/administration faces challenges due to **a lack of data regarding the extent and depth of peatlands.** Detailed mapping supporting understanding the ecological and economic value of peatland is required. At the same time, **restoring peatland is expensive and data on the effectiveness of intervetions on a granular level is lacking.** Especially for restoration projects/initiatives, reliable data (at low cost) is required to map and track peatland restoration interventions and their effectiveness (e.g. canal blocking effects) – and identify opportunities to reduce the cost of peatland restoration. The information provided would help to design further interventions that could provide incentives for local farmers and communities to adopt and improve sustainable agricultural practices and enable additional potential income sources such as ecosystem service payments. Beyond that, linking peatland restoration to specific funders/investors would enable more secure/reliable peatland restoration activities, combined with necessary insurance models or fire protection infrastructure (see also the Katingan project, http://katinganproject.com).

In which market/industry would you categorize your idea?

Agriculture, Microelectronics, Information management

#3: PEATLAND HEALTH AND RESTORATION MONITORING AND INTERVENTION EFFECTIVENESS


Source: DPA

Why Fraunhofer

- Image Analysis and Pattern Recognition at e.g. IIS, IOSB
- Ecological know-how at e.g. IME
- Environmental sensing at e.g. IPMS
- Sensor technologies at e.g. IPM

What piece of technology are you lacking?

Technology for integrating the required (real-time) information base that enables peatland mapping, health and restoration monitoring

- Satellite imagery data integration and analysis (e.g. land cover, forest cover) from existing platforms (e.g. Global Forest Watch data base, GLAD – Global Land Analysis & Discovery, Google Earth Engine, Trends.Earth)
- Aerial (e.g. UAV) image recognition algorithms (e.g., LiDAR models, identify burn scars, canals, water levels, vegetation types)
- Data integration & mapping extent and depth of peatlands (e.g. digital terrain/surface models) for comprehensive peatland data sets
- Real-time remote sensing and sensor-based data collection (i.e. extent & depth, biodiversity, vegetation, water chemistry & levels, etc.)
- Potentially health of vegetation monitoring / conditions of plants

Analytics and linking of data to local action and actual interventions (partner and project data)

- Local partner (e.g. BRG – Indonesia Peatland Restoration Agency, RSPO – Roundtable for Sustainable Palm Oil) and respective data matching and integration (e.g. continuous mapping of forest moratoriums, restoration plan mapping, local concessions)
- Linkage with actual peatland restoration project data to assess the effectiveness of interventions (e.g. canal blockage positions)
- Engagement interface to actual (potential) action on the ground – e.g. through virtual data platform or tailored reports to present and monitor peatland development & restoration in Indonesia with application program interfaces to/from other sources/solutions
- Analytics algorithms (e.g. assessment of state versus trends) for vegetation monitoring with learning advise (e.g. re. cost efficiency)

What is your R&D need and what do you expect Fraunhofer to deliver?

Building on an effective and integrated data and information base, it is key to establish analytics that advance the understanding if intervention effectiveness and provide advice for cost improvement opportunities for currently expensive peatland restoration activities. Beyond that, finding novel ways to make such insights actionable and linking it to real projects could substantially improve speed, quality and scale of restoration activities.

In what of the suggested research field would you categorize your idea/problem to be solved?

Agriculture, environmental sciences, remote sensing, machine learning, computer vision, ecology, earth observation, biological sciences, civil engineering, electrical engineering, environmental biotechnology

#4: ASSESSING AND MAPPING CO2E SEQUESTRATION POTENTIAL ACROSS RAINFORESTS, PEATLANDS, AND AGRICULTURAL AREAS


Source: GlobalForestWatch

What is your overall vision?

The vision is to improve CO2 sequestration transparency and thereby enable a carbon ecosystem service market supporting the protection and restoration of forests and peatlands as well as the expansion of sustainable agriculture practices such as agroforestry. Tropical forest finance and carbon forestry builds on strong momentum and a growing group of committed stakeholders – from governments (e.g. land use policy), local & international companies (e.g. Offsetting), individuals, voluntary platforms, or international organizations (e.g. REDD+ - Reducing Deforestation and Forest Degradation in Developing Countries). 50 bnUSD annually have to be contributed to tropical forest finance such as REDD+ by 2030 in order to limit global warming to +1.5 degrees Celsius– among other measures of course. At the 2015 United Nations Climate Change Conference in Paris, Germany, Norway and the United Kingdom pledged to contribute $5 billion in tropical forest finance by 2020. The pledge is on course to being fulfilled. It is key to catalyse capital efficiently into sustainable carbon forestry and land use. Current approaches to measuring carbon sequestration potential are expensive as well as limited in terms of regional granularity and the usability by local stakeholders.

Exemplary SYSTEMIQ expertise and validation partners

- Food and Land Use Coalition
  The Food and Land Use Coalition
- Projects with reforestation/ agroforestry NGO's and social businesses
- Partnership4Forests
  Partnership for Forests
- Projects with among others the Indonesia Peatland Restoration Agency BRG

What customer problem are you trying to solve and why is this promising?

Significant steps forward have been made on forest monitoring, including increasingly robust national systems established in several countries, along with global satellite monitoring tools such as Global Forest Watch. However, all stakeholders **require more precise mapping (e.g. standing tropical forests, peatland forests) and reliable data on the CO2e sequestration potential (e.g. quantification of restored/conserved amounts) to enable and scale incentives** for sustainable agriculture such as agroforestry, reforestation and forest/peatland protection. This is the basis needed for scaling emerging **carbon ecosystem service markets/platforms. Technology innovation is essential to make such approaches cheaper, more transparent and faster for effective use across stakeholder groups** (e.g. further problems include dependency on local specification and emerging tech. maturity). The international community/policy makers requires such data for carbon footprint compensation models/platforms to reliably and transparently deduct payments for offsetting projects supporting the lungs of the world. Data and potential ecosystem service payments has to be made transparent and available to incentivise farmers and local communities to adopt sustainable agriculture practices such as agroforestry. Researchers rely on the data for better modelling, conservationists for better protection arguments and the administration for better informed policy-decisions.

In which market/industry would you categorize your idea?

Agriculture, Mobile & Telecommunications, Microelectronics, Information management

Source: SYSTEMIQ analysis

#4: ASSESSING AND MAPPING CO2E SEQUESTRATION POTENTIAL ACROSS RAINFORESTS, PEATLANDS, AND AGRICULTURAL AREAS


Source: GlobalForestWatch

What piece of technology are you lacking?

- Data crawling/aggregation technologies integrating existing information such as satellite data (e.g. Global Forest Watch data base, GLAD data – Global Land Analysis & Discovery, Google Earth Engine, Trends.Earth)
- Data matching algorithms and integration from aerial mapping or airborne measurement systems (e.g. field plots, images by drones/UAV or aerial vehicles, LiDAR models)
- Integrated mapping extent and depth of forests/peatlands (e.g. digital terrain/surface models)
- Image recognition algorithms (e.g. convolutional neural networks, deep learning for plant classification) using such data to identify and categorize plants and crops as well as their dimensions (height, treetop diameter) for biomass modelling
- Analytic computation & data interpolation models specifying CO2e sequestration potential (full coverage, above/in-soil)
- Linkage to carbon certification modes (e.g. PlanVivo) and interface to (voluntary) carbon markets/carbon forestry platforms
- Linkage to local project data and initiatives (e.g. P4F – Partnerships for Forests), e.g. for field measurements and program matching
- Integration of local legal and system information (e.g. land tenure rights)
- (Predictive) Analytics algorithms feeding into virtual data platform with application program interfaces to/from other solutions to be used by respective investors, policy makers, farmers/unions

Why Fraunhofer

- Image Analysis and Pattern Recognition at e.g. IIS, IOSB
- Aerial vegetation monitoring at e.g. IPM
- Ecological know-how at e.g. IME

What is your R&D need and what do you expect Fraunhofer to deliver?

Key research challenge is to develop analytics models that integrate available data efficiently (globally and locally) and allow for CO2 sequestration analytics at scale and low-cost while achieving high regional granularity and considering local parameters (e.g. land tenure rights). Creating an easy-to-ease interface for insights at an improved cost level would enable acceptance across stakeholder groups.

In what of the suggested research field would you categorize your idea/problem to be solved?

Agriculture, environmental sciences, remote sensing, machine learning, computer vision, ecology, earth observation, biological sciences, civil engineering, electrical engineering, environmental biotechnology

Source: SYSTEMIQ analysis