



Collaboration between Wageningen University & Research and the Caribbean



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UNIVERSITY & RESEARCH

Preface

As rector magnificus of Wageningen University I'm very proud that we're able to show in this booklet the projects experts and scientist of Wageningen University & Research (WUR) are implementing in the Caribbean. The Netherlands itself has a strong and dynamic relation with the region specifically with the countries of the Kingdom of the Netherlands (Aruba, Curaçao and Sint Maarten) as well as with Surinam. In 1967 Wageningen University established the Centre for Agriculture Research in Suriname, as a branch of the Agriculture College of Wageningen. The centre now still carries out research in Agriculture and Forestry and is an important reference centre in the country, currently under the Dirección of an Alumna of Wageningen University.

Personally, I have been engaged regularly with the Caribbean as well as with Surinam. I have been the co-author of books investigating the challenges of environmental management in Curaçao (1997) and Surinam (2004). And in 2014 I was promotor of a PhD research on climate change and Caribbean tourism, specifically on the modelling of adaptation and vulnerability. I have always been fascinated by the huge challenges small island development states (SIDS) in the Caribbean face regarding sustainability and climate change. And how these environmental challenges interfere with others: economic crises, inequalities, earthquakes, hurricanes, sargassum blooms, boycotts, Covid-19, to name just a few. Against these huge and interdependent challenges small island developmental states have limited capacities to cope with them, which only increase the necessity of collaboration.

With this booklet Wageningen University & Research offers a selection of WUR expertise that might be – and sometimes has been – of help to the region in facing these complex challenges, as well as in creating opportunities and innovations that strengthens each and every island in a sustainable development path. Wageningen University & Research, as the leading global university in agriculture, food and the environment, is eager to strengthen existing and establish new partnerships in the Caribbean to support sustainable development and solid and resilient water, food and environmental management systems for each and every island.



Prof. dr. ir. Arthur P.J. Mol
*Rector Magnificus of Wageningen University and Vice-President
Executive Board of Wageningen University & Research*



* Mexican, Colombian and Venezuelan students have not been included in this map, because the main part of these students are from inland (not from the Caribbean coast)

Atlantic Ocean



Introduction

The Caribbean is a region in the Americas with islands and coasts bordering the Caribbean sea. Three countries of the Kingdom of the Netherlands (Aruba, Curaçao and Sint Maarten) and the three special municipalities Bonaire, Saba and Sint Eustatius are placed in the Caribbean and main the reason why Wageningen University & Research has been and is doing quiet some research in the Caribbean. Also still a historic and dynamic relation with Suriname exist and the new government and the easiness of sharing a common language created new opportunities with ministries, research institutes and the University of Anton de Kom in Surinam.

In the second half of 2022 visits of several WUR experts to other Caribbean islands are foreseen and beginning 2023 WUR expects to come up with a strategy to work on specific topics with partners in the Caribbean in the framework of challenges faced by Small Island Development State. This booklet is a first step and offers you an overview of the research of WUR in the Caribbean. Apart from the projects in the Dutch Caribbean (on for example ecology of the valorisation of Sargassum) it shows you work on food security in Cuba and fruit quality in Haiti as well as marine research under water on corals, sea turtles and sharks.

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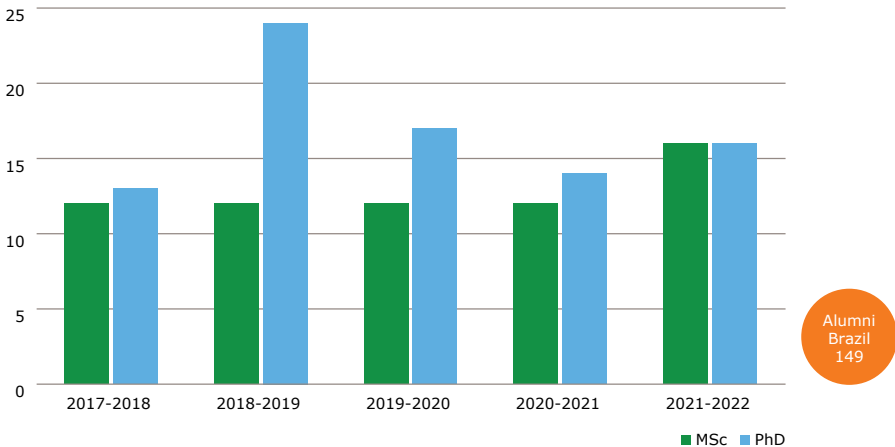
Students

In this academic year 2021-2022, Wageningen University & Research has 37 students from the Caribbean: 5 BSc, 16 MSc students and 16 PhD candidates. In 2020 we counted 149 alumni from the Caribbean who have graduated from Wageningen University & Research.

Student numbers Caribbean (total) of the following countries:

- Surinam
- Costa Rica
- Panama
- Cuba
- Honduras
- Trinidad & Tobago
- Nicaragua
- Jamaica
- Barbados
- Puerto Rico
- Saint Kitts and Nevis
- Dutch Antilles
- Aruba
- Curaçao
- Cayman Islands
- French Guiana

** Mexican, Colombian and Venezuelan students have not been included in this list, because the main part of these students are from inland (not from the Caribbean coast)*



Brazil - total amount of students (MSc and PhD)

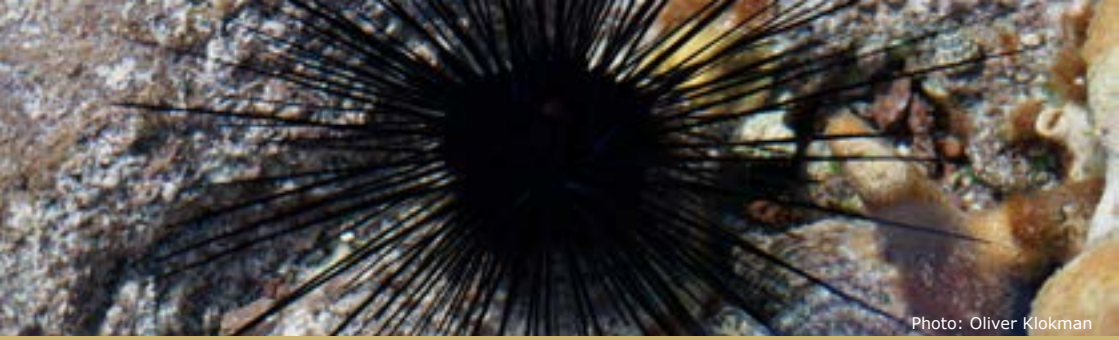


Photo: Oliver Klokman

Diadema: key to healthy coral reefs

From 2019 - 2023 | Total budget € 700,000

The RAAK PRO Diadema project aims to restore long spined sea urchin populations (scientific name *Diadema antillarum*) on the coral reefs around Saba and St. Eustatius. Long spined sea urchins were the most important herbivores on Caribbean coral reefs.

In 1983, more than 95% of the sea urchins died, due to an unknown disease. Without the grazing sea urchins, the algae were no longer consumed and increased in abundance, smothering adult corals and inhibiting the settlement of juvenile corals. As a result, the reef became covered with algae instead of corals. Nowadays, more than 35 years after the die-off, long spined sea urchins are still very rare. They are sometimes abundant in shallow waters, such as harbors, but are seldom seen on the deeper coral reef. University of Applied Sciences Van Hall Larenstein and Wageningen University and Research work together with local partners on the RAAK PRO Diadema project. The overall aim of the project is to develop active intervention methods to restore the populations of this important herbivore. The project is funded by the Dutch Organization for Scientific Research (NWO).

More information

<http://www.vhluniversity.com/diadema-en>

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Sustainable and circular organic waste and sargassum management on Bonaire (BONCIRC)

From 2022-2024 | Total budget € 900,000

In the BONCIRC project circular approaches to sustainable management of organic waste streams in the Dutch Caribbean, using Bonaire as a case study will be developed. At Bonaire, organic waste is collected jointly with other waste and mostly landfilled. This causes GHG emissions, nutrient leakage and eutrophication of natural environments and the coastal habitat. The biomass collected from the Sargassum seaweed influxes, that cause severe environmental damage in the coastal ecosystems, will be incorporated to the waste streams. During the project, organic residues and wastes (food waste, agricultural residues, manure, garden waste, Sargassum, etc.) are mapped and assessed in terms of amounts over the year, composition, current uses and potential uses, circularity of current uses and expected development over time. Uses of sargassum biomass, that currently is disposed of, will be studied in combination with other organic wastes thereby creating (more) circular value-chains that contribute to regenerating natural (marine) habitats and agriculture. Because of the diversity of wastes, several applications will be studied: 1) Direct applications for food/feed products, 2) Applications of (mixed) organic waste streams, digestate from anaerobic digestion and wastewater as substrate for compost or soil enhancers (reducing imports) and 3) The production of biogas (for electricity generation, replacing fossil diesel) and digestate based compost from the organic wastes and Sargassum.

Acknowledgement: This project was financed by the Dutch TKI- Agri & Food programm, with project nr LWV21.204

More information

<https://doi.org/10.18174/543797>

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Distribution of vascular plants on the Dutch Caribbean islands

From 2020-2022 | Total budget € 40,000

Ecosystems on the Dutch Caribbean are under threat due to climate change, urbanisation, change of land use and invasive species. Detailed knowledge on the distribution of vascular plants is crucial for conservation and sustainable land use. However, data on the distribution of plants on the Dutch Caribbean are scarce, which is typical for tropical ecosystems. In addition, large amounts of available distribution data have not yet been digitised. The lack of available data hampers conservation efforts and decision making on land use.

The project foresees the construction of an updated species list of vascular plants and the digitization of approx. 50,000 plant records retrieved from vegetation surveys, inventories, literature, apps, photo archives and herbarium records. All data will be presented on a grid base through an interactive web-server on the Dutch Caribbean Biodiversity Database website (www.dcbd.nl) and will be uploaded to GBIF. The resulting distribution maps will indicate threatened species and areas of conservation interest.

The project is carried out in close co-operation with Carmabi (Curaçao). Local partners on the islands are involved, including governments, national park agencies and private persons. Others are invited to contribute data such as photos, digital observations or reports with plant inventories.



More information

www.synbiosys.alterra.nl/caribbean

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Connecting Cuban farmers to the Network of Lighthouse Farms

From 2021-2023 | Total budget € 32,999

Cuba's agricultural model is characterised by strong centralised planning and control, leading to limited (inter)national cooperation and restricted access to the international market. This limits farmer's autonomy in access to inputs and sales markets, but also constrains sharing and exchanging knowledge and experiences through (intern)national networks and cooperation.

Yet, a number of entrepreneurial farming initiatives, known for their high level of innovation with a vision to provide agroecologically produced food for the local population is growing. These initiatives demonstrate that agroecological farms are economically viable production models that may contribute to food security in a sustainable way. Learnings from the Global Networks of Lighthouse Farms indicate that one powerful mechanism to support the exchange and spread of innovations is through exchange networks. The network provides a clear channel for (inter)national cooperation, and a clear pathway to amplify innovations to the wider farming community.

This project will enable outstanding entrepreneurial initiatives in Cuba to further grow in their knowhow by connecting them with internationally renowned initiatives via the Global Network of Lighthouse Farms and support the creation of Cuba's own lighthouse network.

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Photo: Guido Leurs

Movement ecology of Reef Sharks

From 2021-2025 | Total budget € 160,000

This BO-43 research for the Dutch Ministry of Agriculture, Nature and Food Quality focuses on studying habitat use and movement patterns of coral reef associated sharks in the Caribbean parts of the Kingdom of the Netherlands. During 2014-2020 an operational network of 32+ detection stations was build that enables to follow individual shark behaviour with acoustic transmitters. This network will be used for this follow-up study that started in 2021. Different species of sharks (namely Caribbean Reef Sharks, Nurse Shark and Silky Sharks) will be deployed with transmitters with sensors to measure habitat use, individual home ranges and the importance of connectivity between different coral reef systems in close cooperation with local NGOs, park managers and dive operators. Because tagged sharks can be tracked during more than 4 years, the main analysis will take place in the last years of the project. The data and acquired knowledge will be used to indicate health of coral reefs and fisheries, determine what (key)habitats are, evaluate conservation zones (local marine parks and the large shark and whale sanctuary YARARI) and furthermore enhance local support and awareness for protection of sharks.

More information

www.wur.nl/en/article/nature-research-in-the-caribbean-netherlands.htm

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Restoration of Resilience of Nature and Society in the Caribbean Netherlands

From 2021-2024 | Total budget € 1,800,000

The Caribbean Netherlands' marine nature, with its unique coral reef ecosystems, is the most important economic resource for Bonaire, Saba, and St. Eustatius. However, these coral ecosystems are under tremendous pressure due to global (e.g., climate change) and local (e.g. tourism, erosion, water use, pollution and chronic eutrophication) stressors. Therefore, balancing fisheries, agriculture, tourism, and water management with the natural capacity of the relevant ecosystems is an urgent policy aim for the Dutch Caribbean. Integrated approaches are indispensable to restore such balance through targeted interventions and increase the resilience of nature, biodiversity and thus also of society.

There is a lack of fundamental knowledge and an integrated approach to coastal management in the Caribbean Netherlands. Therefore the current project aims to set up new infrastructures to address this shortcoming. By applying novel (e.g., eDNA, metabolomics, remote sensing, and passive sampling), traditional (e.g., water quality parameters, isotope analysis, digital evaluation models, bathymetry data) and smart technologies (e.g., AI-based data processing and underwater drones), in concert, this project will ultimately provide better insights into which policy can more effectively restore and safeguard nature and the services it provides.

More information

www.wur.nl/en/Research-Results/Research-funded-by-the-Ministry-of-LNV/Expertisegebieden/kennisonline/Restoration-of-resilience-Dutch-Caribbean.htm

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Microalgae cultivation on Bonaire

From 2017-2022 | Total budget € 800,000

Microalgal biomass can be used for food, feed, and biofuels. To grow these microalgae efficiently we need high light levels. Bonaire was chosen as a pilot location as this Caribbean island offers such light levels, all year round. In addition, cultivation of microalgae can benefit the island by creating possibilities for producing food locally, instead of importing it.

In this project we focus on setting up a microalgae production process, designed for the climate conditions of Bonaire. One challenge here is the high temperature that production systems reach due to the high light levels. Cooling is expensive and climate unfriendly, and should therefore be avoided. Therefore, we use indigenous thermo-tolerant microalgal species which do not require cooling. We try to understand how these species can cope with high temperature. In addition, we designed a novel production system which utilises light dilution and passive temperature buffering to prevent overheating. The project was conducted by the group of Bioprocess Engineering at WUR. Funding was provided by the Dutch Research Council (NWO) within NWO Caribbean Programm with project number ALWCA.2016.029.

An example of a project description at the other page (comes from the Colombian booklet that we made before)

More information

www.wur.nl/en/article/algae-grow-better-on-bonaire.htm

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Assisting Haitian fruit smallholders

From 2017-2021 | Total budget € 400,000

In Haiti a start has been made to change the mango and avocado harvest and transport system and to obtain better prices for small farmers. Experts from the Wageningen Centre for Development Innovation and Wageningen Food & Biobased Research enabled this by providing technical advice, by bringing chain parties together and by introducing greater transparency in the chain. The project is implemented by the Ministry of Industry and Trade, funded by the WB.

Haitian Mangos sell for two dollars in American supermarkets, two to five cents of which go to the farmers. The project's role is to trigger the system to become more sustainable, more transparent and more inclusive for farmers. A better system will give farmers the financial scope to make small investments in the further development of the sector. The development of postharvest Standard Operational Procedures form the basis for the project. These were formulated and tested and provide data on time, temperature and transport, to be used for blockchain or other chain information applications. Significant improvements can be made to the logistical handling of mangos with a few relatively simple steps. The application of blockchain enables farmers to remain owner of their fruits until final B2B sale in the US and the trader to be replaced by a Logistical Service Provider.

This system ensures transparency for consumers and can therefore be regarded as a new form of fair trade. It also gives farmers the opportunity to remain the owner of the products until they are sold to supermarkets. Currently WUR is advising on the design of mobile packing units for tropical fruits, which are expected to be tested in the second half of 2021.

More information

www.youtube.com/watch?v=xpKe8J2i0Wo

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INREEF: Building resilience of marine protected areas in tourism destinations

From 2021-2027 | Total budget € 1,200,000 + 1,000,000 co-funding

Increasing evidence shows that the resilience of coral reefs can be strengthened by adaptive management strategies that reduce local stressors. In a collaborative effort, we identify and develop the tools to analyze how the resilience of Marine Protected Areas (MPAs) can be (i) measured, (ii) monitored, and (iii) governed to safeguard the coral reefs in a future of fluctuating tourism and climate change. MPAs consist of interlinked ecosystems, socioeconomic systems, and governance arrangements, that require an interdisciplinary approach to fully grasp the complex feedbacks.

Our program builds on a strong network of international and transdisciplinary partnerships with 9 knowledge institutions, 8 NGOs involved in MPA management, 6 governmental institutions and 7 parties from the private sector in the Dutch Caribbean and Indonesia. Output:

- Interdisciplinary online education and training programmes
- MPA resilience dashboard to provide 1. comprehensive overview of the MPA status, 2. decision support tool for adaptive management, 3. publicly accessible tool for awareness building
- Governance toolbox evaluating ecological and socio-economic impacts of management strategies and informing on effectiveness and efficiency of policy interventions.
- Technological interventions for wastewater pollution

More information

www.wur.nl/en/Research-Results/Research-Institutes/marine-research/show-marine/INREEF-Interdisciplinary-program-to-build-the-resilience-of-marine-protected-areas-in-tourism-destinations.htm

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Global wildlife loss and plant invasion

From 2018-2021 | Total budget € 250,000

Cascading effects on seagrass ecosystem services

Ecosystems are currently altered by human-induced changes in large herbivores and invasive species abundances. Researchers investigated how green sea turtles, as large grazers, and invasive seagrass interactively affect seagrass ecosystem services.

Cascading effects of the presence of predators on green turtles and ecosystem resilience were monitored. The project helped to identify pathways for effective management of critical seagrass habitat through management of its herbivores and their predators.

More information

penyu.nl

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Ecology and protection of sea turtles

From 2019-2023 | Total budget € 500,000

Caribbean cruisers in the Kingdom of the Netherlands: ecology and protection of sea turtles

What do we know about the icon of the Caribbean, the sea turtle?

Sea turtles in the Dutch Caribbean, the green and hawksbill sea turtles, are iconic animals. In accordance with international treaties, the Netherlands is obliged to ensure the protection of sea turtles. However, good nature conservancy policy must be supported by scientific knowledge about these animals.

This project retrieved many facts about the sea turtles by investigating their migration routes, population structures and use of their living environment. Periods of ocean cooling and warming exert a large influence on the size of sea turtle populations and their migration. The current global warming threatens the eggs in the nests, but some simple shading can reduce the nest temperature. After centuries of overhunting, populations in the western Caribbean seem to be recovering better than in the eastern part.

Researchers used satellite transmitters to map where the turtles nest, where they seek food and how they migrate between these locations. The green turtle is suffering from an encroaching exotic seagrass from the Red Sea, which it does not eat.

More information

[www.nwo.nl/en/
what-do-we-know-about-icon-caribbean-sea-turtle](http://www.nwo.nl/en/what-do-we-know-about-icon-caribbean-sea-turtle)

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Dry Forest Resilience and Restoration

From 2021-2023 | Total budget € 25,000

The Caribbean islands host one of the world's hotspots of biodiversity. Yet, extensive deforestation and overgrazing by feral livestock have resulted in loss of biodiversity, soil erosion and overflow of nutrients and sediments in coastal systems. Large scale restoration of terrestrial vegetation can reduce soil erosion improving the functioning of mangroves, seagrass fields and coral reefs that are essential for coastal protection to hurricanes and sea level rise. Restoring inland vegetation can also contribute to reduce the impact of future warmer climates on wildlife and people.

We aim to understand the resilience of dry forests and how to facilitate their restoration. We use field surveys and experiments to:

- assess the effects of herbivores including feral goats;
- monitor natural forest regeneration;
- assess active restoration projects;
- evaluate the ecological mechanisms that explain vegetation recovery
- evaluate the effects of ecological restoration on wildlife and inter-connected ecosystems

We team up with local organisations (e.g. ECHO, STINAPA) and colleagues from different disciplines and institutions to jointly understand the best ways to restore the natural richness of Bonaire.

More information

<https://www.wur.nl/en/project/Dry-Forest-Resilience-and-Restoration.htm>

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Bonaire 2050, a nature inclusive vision

From 2019-2022 | Total budget € 640,000

What would Bonaire look like in 2050? A future in which a sustainable economy and a nature inclusive society go hand in hand to maintain what is precious, and to restore what is damaged. Experts from the island and Wageningen University & Research addressed that question by working together with stakeholders on the island.

The very diverse landscapes of Bonaire range from dry cacti forests, traditional kunukus, biodiverse reefs, to extensive salt flats. For each of Bonaire's landscapes a vision with potential nature inclusive measures was mapped during design sessions, interviews and workshops with local experts, decision makers and researchers in the field of nature, culture, recreation, agriculture and governance.

The resulting drawings of each of the landscapes show measures such as rooftop water harvesting, reforestation, greening gardens, growing local food, creating cactus fences, installing solar panels, and coral restoration to meet the challenges ahead. These challenges include managing (mass-) tourism, preventing high erosion rates that are due to free-roaming cattle, and adaptation to sea level rise. The measures and challenges are symptomatic for many small tropical islands.

More information

www.dcbd.nl/document/bonaire-2050-nature-inclusive-vision

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Living Lab Bonaire: an integrated approach for sustainability

From 2019-2022 | Total budget € 175,000

Bonaire has a unique environment and biodiversity; it has the richest biodiversity in the Netherlands.* These unique characteristics make this small island an ideal showcase to develop a circular economy while respecting nature. At least 13 groups from WUR's different domains do research on Bonaire. In 2019, a Lab was inaugurated because of the cooperation between the Bioprocess Engineering Group (BPE/AFSG/WUR) and Water en Energie Bedrijf (WEB/Bonaire); a joint investment of 175K€. Together, these partners develop a project on sustainable microalgae production on the island (2017-2022). Our ambition is to turn this space into a living one; open to innovation and social engagement to solve complex socio-ecological problems, with multiple organisations as users: Living Lab Bonaire (LLB). In 2020, STINAPA (Bonaire's National Parks Foundation) became a member of LLB, bringing in more equipment and support materials.

Currently, we are equipped with basic lab facilities: fridges, freezers, milliQwater, spectrophotometer, photosynthesis measurements (aquapen), scales, oven and muffle, fume hood, water baths, tissue grinder and vortex systems, refractometer, light, temperature and pH meters, pipettes, filtration systems, ect.

* Ecological values of the 12 miles zone of Bonaire Imares report C026/16 (2016)

More information

www.algaeparc.com/projects/6/algaeparc-bonaire

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Traditional rice cultivation in Suriname

From 2021-2025 | Total budget € 682,753

Suriname Maroons are descendants of enslaved Africans who escaped from the plantations in the 17th and 18th century. Maroons grow hundreds of rice varieties that are hardly known to science but differ substantially from modern cultivars. Where does the Maroon rice come from? This project, financed by ENW-Klein II (NWO), combines ethnobotanical, historical and genomic research and links Maroon oral history to written sources from colonial archives and the DNA of their rice. Maroon rice fields probably reflect 370 years of migration and adaptation: ancient African landraces, historic US cultivars, rice exchanged with Asian contract laborers and self-developed varieties. This project contributes to the revaluation of a food crop with substantial importance for current and future food security and Afro-American cultural heritage.

This project, entitled *Hidden crop diversity in Suriname: tracing the origins of Maroon rice by integrating ethnobotany and genomics*, is carried out by Tinde van Andel (Naturalis, WUR) and Eric Schranz (Biosystematics, WUR), Harro Maat (Social Sciences, WUR), postdoc (genetics) Marieke van de Loosdrecht (WUR) and PhD student (ethnobotany) Nicholaas Pinas (Naturalis).

More information:

www.wur.nl/en/project/hidden-crop-diversity-in-suriname-1.htm

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Integration of SarSentry with the National Forest Monitoring System of Suriname

From 2020-2024 | Total budget € 400,000

Forests cover 93% of Suriname. To improve monitoring of the forest area, SarSentry methodology was demonstrated. Its capabilities to automatically detect and quantify forest degradation, even at light disturbance levels, are unprecedented. Other advantages are the near real-time (NRT) and fully automated production of disturbance maps (usually within two days after satellite overpass, covering the entire country, every 12 days) and the all-weather capability (because it is based on cloud-penetrating Sentinel-1 radar data).

The project will strengthen the National Forest Monitoring System (NFMS), specifically its NRT monitoring component. By integrating SarSentry within the NRTM, it can be used as a solid basis to enable the relevant authorities to react on possible encroachment immediately and to monitor compliance with licensed selective logging requirements.

The first phase of activities was conducted in the period 2020 until early 2022 within the larger framework of the WWF Forest Foresight programme, with a focus on demonstration. The second phase aims at technology transfer and capacity building and is scheduled for the period end of 2022 until 2024. The work is executed by Wageningen University and SarVision in collaboration with ISRIC, Foundation for Forest Management and Production Control (SBB), Ministry of Land Management and Forestry (GBB) and Anton de Kom University.

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Climate Change Impact assessment in two regions of Suriname

From 2022 - December 2022 | Total budget € 75.000 USD

One of the main threats of climate change on food systems are changes in the rainfall and temperature patterns often leading to an increase of the salinization in the soil and water. This is caused by sea level rise (SLR), increasing temperatures (more evapotranspiration) and changes in precipitation patterns. In this context, Suriname is developing a proposal to the Green Climate Fund (GCF) to improve the capacity of the Ministry of Agriculture of Suriname to build resilience to climate change in the agriculture sector. Under the overall objective of increasing the capacity of the Ministry of Agriculture of Suriname to prepare Climate Change projects, Wageningen Environmental Research (WEnR) will assist the Ministry in 2022 by preparing a climate change impact assessment study. The project will focus on the following three activities:

- 1 Perform a high-level, data-driven impact analysis of the vulnerability of crop yields in Suriname to flooding, drought and salinisation due to climate change, for 4 different crops (Rice, Banana, Cocos and mixed vegetables) and 2 regions (Nickerie, Coronie/Saramacca);
- 2 Development of a prototype database of agricultural and hydrometeorological data for the agricultural sector in Suriname, extracted from global databases as well as country-specific data based on locally available data;
- 3 Capacity building events for the staff of the Ministry of Agriculture and its implementing partners

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The mission of Wageningen University & Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 7,200 employees (6,400 fte) and 13,200 students and over 150,000 participants to WUR's Life Long Learning, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.

More information

www.wur.eu/

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Colophon

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