Engaging Communities for Biodiversity Conservation:

Education for Sustainable Development Projects from the Global RCE Network

Editors:
Philip Vaughter
Jonghwi Park
Nancy Pham

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Philip Vaughter
Jonghwi Park

Technical editing and coordination:
Nancy Pham

Contributor/s:
Jaewook Sung

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Artem Sapegin | unsplash

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Foreword by UNU-IAS

We are currently in the midst of what experts call the sixth extinction – an extinction event that has been ongoing since the end of the last ice age. This event has spanned both terrestrial and marine environments, with species disappearing across all type of landscapes and seascapes at 100 to 1,000 times the natural background extinction rate. An astonishing array of lifeforms spanning numerous families of life on earth have vanished from the biosphere and many more are at risk of disappearing; not only from the animal kingdom, but many species of plants, fungi, and microorganisms as well. Indeed, many of these species have likely vanished from the biosphere before becoming known to humanity.

This ongoing extinction event is placing humanity in jeopardy, but our collective behaviour is the driving force behind it. The agricultural revolution brought with it the capacity to feed a greater number of people than ever before; however, as generations upon generations cleared forests, wetlands, and grasslands for cropland and pastures, we were losing parts of the biosphere upon which we depended. This process was further accelerated by the industrial revolution, which continues to bring great development gains for many – such as improved living conditions, improved access to education, and longer lives – but has also driven up the extinction rate rapidly across the biosphere.

The question now is how can we protect and expand these improved living standards while protecting the biosphere and all life within it. There is no single or easy answer, as a diverse array of human activities drives the loss of biodiversity. But recognition of the varied causes of the problem may hold the key to the answers that we need. While biodiversity loss is a global problem, it is driven by patterns of development at the local level. Each locality has its own ecology and pattern of development, and thus local communities are often the best situated to develop solutions. Often the first step needed to enact solutions is education. Without education, communication, and public awareness, many stakeholders within a given community are unlikely to take conservation of biodiversity into consideration in their daily lives. Education for sustainable development (ESD) is


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Sebastian Unrau | unsplash

an enabling mechanism that allows for learners of all ages to receive the knowledge and training they need to enact sustainable development within their surrounding environment. The United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS) has been developing and implementing the ESD agenda for 17 years through a range of initiatives, including our global network of Regional Centres of Expertise (RCEs) on ESD. RCEs are localised networks of actors, including school systems, higher education institutions, non-governmental organisations (NGOs), city governments, and many other actors that work together to create an integrated agenda for using education and training to address sustainable development challenges in their region. Through creating synergised ESD projects to protect the biosphere, RCEs are key enablers for education and awareness-raising activities that contribute to international processes such as the Convention on Biological Diversity (CBD).

This publication presents a diverse set of ESD projects that illustrate ways forward through actionable steps to protect and restore the biosphere using ESD practices. It is our hope that this book can serve as a starting point for dialogue and learning on how to address biodiversity loss in each community. While the biomes and communities featured in this publication are unique, many of the sustainable development challenges they are addressing – such as habitat destruction, water pollution, and resource extraction – are similar to those facing other communities around the world. By learning from these examples, we hope that communities in every region can take the necessary steps from learning to applied action for biodiversity conservation.

Shinobu Yume Yamaguchi
Director
United Nations University
Institute for the Advanced Study of Sustainability (UNU-IAS)


Melissa Askew | unsplash

Foreword by IUCN Commission on Education and Communication

We are currently facing serious human-driven environmental challenges, including biodiversity loss, climate change and resource overconsumption. These challenges are interrelated: when the climate changes, it affects species and ecosystems. Likewise, when human activity alters ecosystems, it threatens their functionality, including their capacity to absorb and store carbon dioxide. Our life depends on healthy ecosystems to breathe clean air, drink clean water, eat healthy and enough food. And we rely on the ecosystems to address the environmental problems we have created too. Nature-based solutions are an elegant solution to benefits for both human wellbeing and biodiversity.

Environmental challenges share a common backdrop and cause: the human-nature disconnect. The time we spend in natural surroundings has been decreasing in the last decades. This affects both our health and our relationship with nature. Being disconnected from nature can lead us to take it for granted, not value it enough, perceive it merely as a resource, with an exclusively utilitarian perspective, and not care for it enough.

To address these human-driven environmental challenges, we need to reconnect with nature, the place where we belong to and come from. Spending time in natural environments and connecting with nature can improve our health, and it can rekindle a love of nature, which can then lead us to cherish and preserve. Since we are nature, we are part of nature, we just need to be reminded of these interconnections – and direct contact with nature is the most powerful tool! When we have direct experiences in nature, we become emotionally closer to it, we develop feelings of appreciation and love towards it, and from there, a deep (re)connection evolves.

Education has a key role to play by inspiring and re-establishing meaningful connections between human beings and nature, and by incorporating a more holistic and integrated living systems approach. Study in and about nature can help understand the interconnections and interdependencies between all living beings, including humans; as well as the interrelationships between environmental issues. Likewise, education can develop knowledge about and stimulate empathy and responsibility towards nature. In this way, education for sustainable development – taking place in either formal, informal or non-formal settings – is a fundamental and critical tool to not only conserve biodiversity, but even more importantly, change the way we perceive and relate with nature.

The IUCN Commission on Education and Communication strongly believes in and advocates for bringing nature and education - including experiential and service-based learning, citizen science and other informal approaches - closer together, as a means to rekindle the human-nature connection. This is why we greatly value and support the work done by UNU-IAS collecting the cases included in this publication. The examples presented in this book are encouraging and inspiring - anyone working in the fields of conservation or education should read them and learn from them. Thank you UNU-IAS for your commitment and work, we celebrate this book and the fruits it will bear.

Katalin Czippán
Co-chair
Nature Education for Sustainability
IUCN Commission on Education and Communication

Featured RCE Biodiversity Projects

A Regional Centre of Expertise (RCE) is a network of existing formal, non-formal and informal organisations that facilitate education for sustainable development (ESD) in local and regional communities. RCEs bring together institutions at the regional/local level to jointly promote ESD. They aspire to use education as a mechanism to translate global objectives for sustainable development into the context of the local communities in which they operate.

RCEs build innovative platforms to share information and experiences and to promote dialogue among regional/local stakeholders through partnerships for sustainable development. An RCE can involve local school systems, higher education institutions, environmental NGOs, museums, zoos, botanical gardens, local governments, local enterprises, volunteer groups, media, civic associations and/or individuals who work in the spheres of sustainable development such as economic growth, social development, and environmental protection.

RCEs Worldwide

As of March 2022, over 170 RCEs have officially been acknowledged by the United Nations University worldwide.

Africa & Middle East

Cameroon:
- Buea

Egypt:
- Cairo

Eswatini:
- Eswatini

Kenya:
- Central Kenya
- Greater Nairobi
- Greater Pwani
- Kakamega-Western Kenya
- Mau Ecosystem Complex
- Mount Kenya
- North Rift
- Nyanza
- South Rift

Lesotho:
- Lesotho

Malawi:
- Zomba

Namibia:
- Khomas-Erongo

Nigeria:
- Greater Yenagoa
- Ilorin
- Kano
- Lagos
- Minna
- Ogun
- Port Harcourt
- Zaria

Senegal:
- Senegal

South Africa:
- Gauteng
- KwaZulu-Natal
- Makana and Rural Eastern Cape

Tanzania:
- Dar es Salaam

Uganda:
- Greater Eastern Uganda
- Greater Kampala
- Greater Masaka
- Greater Mbarara

Zambia:
- Lusaka

Zimbabwe:
- Harare
- Mutare

Europe

Albania:
- Middle Albania

Austria:
- Graz-Styria
- Vienna

Belarus:
- Belarus

Czech Republic:
- Czechia

Denmark:
- Denmark

Finland:
- Helsinki Metropolitan

France:
- Bordeaux Aquitaine
- Brittany
- Paris Seine

Germany:
- Hamburg
- Munich
- Nuremberg
- Oldenburger Münsterland
- Ostwürttemberg
- Ruhr
- Southern Black Forest
- Stettiner Haff

Greece:
- Central Macedonia
- Crete

Ireland:
- Dublin

Italy:
- Euroregion Tyrol

Lithuania:
- Vilnius

Netherlands:
- Fryslân

Poland:
- Warsaw Metropolitan

Portugal:
- Açores
- Creias-Oeste
- Porto Metropolitan Area

Russia:
- Nizhny Novgorod
- Samara

Serbia:
- Vojvodina

Spain:
- Galicia

Sweden:
- North Sweden
- Skane
- Uppsala-Gotland
- West Sweden

Switzerland:
- Zurich

United Kingdom:
- East Midlands
- Greater Manchester
- London
- North East
- Scotland
- Severn
- Wales
- Yorkshire & Humberside

The Americas

Argentina:
- Cuenca del Plata

Brazil:
- Curitiba-Paraná
- Rio de Janeiro

Canada:
- British Columbia
- Greater Sudbury
- Mauricie/Centre-du-Quebec
- Peel
- Peterborough-Kawartha-Haliburton
- Saskatchewan

Colombia:
- Bogota

Guatemala:
- Guatemala

Mexico:
- Borderlands Mexico-USA
- Western Jalisco

Peru:
- Lima-Callao

Puerto Rico:
- Puerto Rico

United States of America:
- Detroit Windsor
- Georgetown
- Grand Rapids
- Greater Atlanta
- Greater Burlington
- Greater Phoenix
- Greater Portland
- Hawaii
- North Texas
- Salisbury
- Shenandoah Valley

Venezuela:
- Gran Caracas

Asia-Pacific

Australia:
- Gippsland
- Greater Western Sydney
- Murray-Darling
- Tasmania
- Western Australia

Bangladesh:
- Greater Dhaka
- Sundarbans

Cambodia:
- Greater Phnom Penh

China:
- Anji
- Beijing
- Greater Shangri-la
- Hangzhou
- Hohhot
- Kunming
- Qingdao
- Suzhou
- Tianjin

India:
- Bengaluru
- Chandigarh
- Delhi
- East Arunachal Pradesh
- Goa
- Jammu
- Kodagu
- Kozhikode
- Lucknow
- Mishimi Hills
- Mumbai
- Srinagar
- Thiruvananthapuram
- Tirupati

Indonesia:
- Bogor
- East Kalimantan
- Yogyakarta

Japan:
- Chubu
- Greater Sendai
- Hokkaido Central
- Hyogo-Kobe
- Kitakyushu
- Okayama
- Omuta
- Yokohama

Kyrgyzstan:
- Kyrgyzstan

Malaysia:
- Central Semenanjung
- Greater Gombak
- Greater Kuala Lumpur
- Iskandar
- Kuching
- Melaka
- Penang

New Zealand:
- Otago
- Waikato

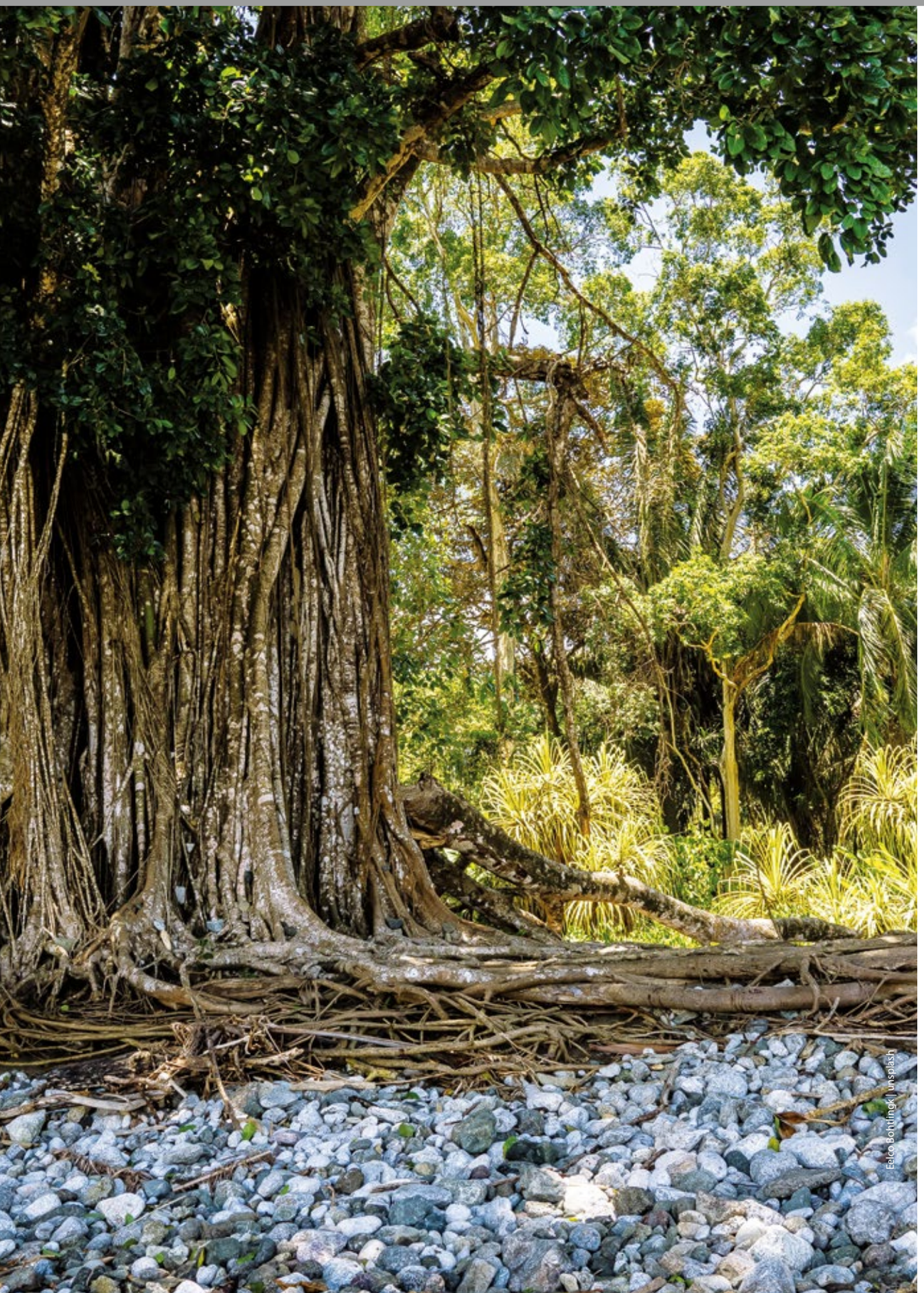
Philippines:
- Bohol
- Cebu
- Ilocos
- Northern Mindanao

Regional:
- Pacific Island Countries

Republic of Korea:
- Changwon
- Dobong-gu
- Gwangmyeong
- Incheon
- Inje
- Tongyeong
- Ulju

Thailand:
- Cha-am
- Maha Sarakham
- Sakon Nakhon
- Trang

Vietnam:
- Southern Vietnam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Education & Biodiversity Conservation

Dr. Philip Vaughter, Research Fellow, UNU-IAS
Dr. Himangana Gupta, JSPS-UNU Postdoctoral Fellow, UNU-IAS

Earth's biosphere is in the midst of an ongoing extinction event. This extinction event has been dubbed the Holocene extinction, the sixth extinction, or more notoriously, the Anthropocene extinction. As its name suggests, the Anthropocene extinction has been driven by human activity, with increasing per capita consumption of resources and subsequent loss of habitat driving the extinction rate of species much higher than the natural background extinction rates observed in the fossil record. While over-hunting and over-fishing are often cited as famous examples of causes for extinction in the modern era, many other activities act as indirect drivers of biodiversity decline. The drive to expand agricultural production contributes to land use change, with forests, grasslands, and wetlands being converted into croplands for monocultures as well as fields for livestock. Continuing infrastructure development and suburban sprawl has fragmented many habitats, making them unsuitable for many species that depend on larger intact areas for their lifecycles. Furthermore, the waste produced through human activity continues to alter the biogeochemical make-up of the planet's air, water, and soil, fundamentally altering the basic building blocks for ecosystems and the species embedded within them.

The United Nations Educational, Scientific, and Cultural Organization (UNESCO) identifies biodiversity as the living fabric of our planet, the rapid decline of which threatens nature and people alike. The former Secretary General of the United Nations, Ban Ki-moon pointed out that biodiversity underpins the functioning of the ecosystems on which we depend for food and fresh water, health and recreation, and protection from natural disasters. Further, the Convention on Biological Diversity (CBD) noted during the United Nations Summit on Biodiversity in 2020, that the global pandemic has underlined the inseparable link between environment and human health, acknowledging that biodiversity loss entails enormous risks to human well-being. There is no doubt that the declining levels of biodiversity will not only impact other lifeforms, but will directly impact humanity as well.

What then can be done to try and protect the diversity of life on Earth within the context of the Anthropocene? While numerous proposals have been offered, CBD has stressed the importance of communication, education, and public awareness (CEPA) as critical instruments for implementing any of these proposals. Education, in particular, is an enabling mechanism for not only identifying and quantifying root causes of biodiversity loss, but also in developing solutions to these problems and subsequently protecting the diversity within the biosphere. But in order to do this, education must go beyond knowledge generation – which formal education and research systems have become very adept at – and train learners how to enact solutions based on the knowledge generated. This critical step goes beyond the purview of many formal

education systems in today's world, but is certainly nothing new to societies which have managed and conserved ecosystems and their component species for countless generations. Building a knowledge base is a critical first step in addressing a problem as complex as an extinction event, but implementing conservation activities that are designed to protect or restore biodiversity needs to be the end goal. It is this type of applied knowledge which goes beyond the confines of classrooms that offers a way forward in implementing solutions to address the Anthropocene extinction as opposed to merely documenting it.

State of Biodiversity Globally

In its 2019 global assessment, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the scientific body to assess the global state of biodiversity and ecosystem services, warned that the rate of global change in nature during the past 50 years is unprecedented in human history *(IPBES 2019)*. Back in the mid-1990s, Pimm et al. *(1995)* found out that the extinction rates are 100 to 1000 times their pre-human levels in taxonomically diverse groups, which was further researched and reiterated in Pimm et al. *(2014)*. We are currently in the phase of the sixth mass extinction, which is happening at an accelerated rate. Ceballos et al. *(2020)* evaluated 29,400 vertebrate species, from which, at the natural baseline rate, one would expect nine extinctions in 150 years between 1900 and 2050. However, it is projected that 1,058 species of vertebrates would become extinct by 2050, making the extinction rate 117 times higher than the background rate. This study also finds that the rate of population loss in terrestrial vertebrates is extremely high, even among 'species of low concern'. Disappearance of one species from the ecosystem erodes the entire ecosystem and pushes other species towards annihilation *(ibid.)*. This is also true for agro-diversity. Declining numbers of insects and other animal pollinators (on which 75% of food crops depend) can disrupt agro-ecosystems, putting food security in jeopardy for many societies around the globe (*Barnosky 2014*). Such diversity loss, including genetic diversity, poses a serious risk to global food security *(IPBES 2019)*. The biodiversity found in and around production systems is vital for food security and sustainable development. Worldwide, crop and livestock production has increased, but at the cost of major disruptions to the integrity of terrestrial and aquatic ecosystems, with declining opportunities for mutually beneficial interactions between sectors, and the loss of components of biodiversity that provide services such as pollination, pest control, and nutrient cycling *(FAO 2019)*.

Biodiversity loss has also been linked to economic loss. Biodiversity decline undermines nature's productivity, resilience and adaptability, which further fuels extreme risk and uncertainty for economies at all scales. The WEF's Global Risk Report 2021 identifies biodiversity loss as an existential threat which continues to top the chart at the fourth position in 2020 and fifth position in 2021, and is likely to impact the global economy significantly *(WEF 2021)*. According to IPBES, nature's contributions to people are deteriorating worldwide. The value of agricultural production (USD 2.6 trillion in 2016) has increased approximately three-fold, and raw timber harvest has increased by 45%. However, at the same time, pollinator diversity has declined, indicating that gains in material contributions are unsustainable. About 75% of the land surface is significantly altered, with over 85% of all wetland areas lost. In addition, 66% of the world's oceans are experiencing increasing cumulative impacts *(IPBES 2019)*.

As far as the drivers of biodiversity loss are concerned, land-use change tops the list, followed by overexploitation as the major driver. Climate change, as a direct driver, also exacerbates the impact of other drivers, thus contributing to


Markus Dubrau | unsplash

Francesco Ungaro | unsplash

changes in species distribution, phenology, population dynamics, community structure, and ecosystem function. Additionally, marine plastic pollution has already affected at least 267 species, including 86% of marine turtles, 44% of seabirds, and 43% of marine mammals, in turn affecting other species throughout food chains. At the same time, invasive species are spreading faster, bringing one-fifth of the Earth's surface at risk of plant and animal invasions, impacting native species everywhere *(IPBES 2019)*.

Loss of biodiversity is also linked to human infectious diseases, which is in turn linked to the wildlife trade. Diseases that are transmitted from other animal species to humans (Zoonosis) account for approximately 60% of all infectious diseases and 75% of emerging infectious diseases in humans. This is likely a result of increased contact between humans, wildlife and livestock *(OECD 2020)*. While some species are going extinct, those that would survive and thrive, like rats and bats, are likely to host potentially dangerous pathogens that can make the jump to humans *(Tollefson 2020)*.

In the face of global biodiversity loss, the 2020 fifth Global Biodiversity Outlook (GBO-5) says that there is a rising awareness on biodiversity concerns. Almost 100 countries have incorporated biodiversity values into their national accounting systems, while the rate of deforestation has fallen globally by about a third compared to the previous decade. Good fisheries management policies involving stock assessments and catch limits and enforcement have helped in maintaining marine fish stocks. In addition, protected area has expanded from about 10% to 15% (terrestrially) and 3% to 7% (marine), while the protection of areas of importance for biodiversity increased from 29% to 44%, over the 2000-2020 period. Contrary to previous decades' trends, the GBO-5 gives good news that the number of extinctions of birds and mammals in the past decade has reduced *(CBD 2020)*. This may have been the result of heightened levels of awareness on the importance of biodiversity as well as formalised biodiversity conservation targets.

There is also evidence that nature is generally declining less rapidly in Indigenous peoples' land than in other lands. However, nature managed by Indigenous peoples and local communities is under increasing pressure *(IPBES 2019)*. Efforts to preserve biodiversity will work only if they address the economic and cultural factors that drive deforestation and the dependency of rural poor people on hunting and trading wild animals *(Tollefson 2020)*. Bending the curve of biodiversity loss is technologically and economically possible but requires transformational change in the production and consumption patterns and sustainable management and conservation of nature *(WWF 2020)*. The recent Dasgupta Review highlights the fact that we have collectively failed to engage with nature sustainably to the extent that our demands far exceed its capacity to supply us with goods and services. Thus, there is a need to transform our financial and education systems, to enable the transformative changes necessary to sustain them, ourselves, and the biosphere. It is essential to establish the vital notion of the natural world in education policy through the development and design of environmental education programmes that have a tangible impact *(Dasgupta 2021)*.

Biodiversity Projects from RCEs

Given the scope of declining biodiversity at a global level, but recognising that all implementation of actionable solutions to address biodiversity loss need to be local, what does a workable education initiative to tackle biodiversity loss look like? A successful approach would need to take specific ecosystems, species, and local communities into account, and keep in mind an initiative would need to educate and engage across an entire community, many of whom would not be in formal education systems. Taking the need for a localised

approach and localised knowledge, as well as the need to work with formal as well as non-formal education systems to maximise engagement, such an initiative may well look like a project initiated by a Regional Centre of Expertise (RCE) on Education for Sustainable Development (ESD).

RCEs are multi-stakeholder networks of both formal education organisations (such as school systems or universities) and non-formal education organisations (including city governments, museums, parks, and zoos) which offer education and training to the general public. Many RCEs also include non-governmental organisations (NGOs) and private sector partners that work with non-formal education through their organisational mandates on education and training. What sets RCEs apart is that this diverse array of actors work together to create an integrated agenda for ESD across a given region, addressing relevant sustainable development topics in a region through education that takes both local ecologies and societies into account. Because RCEs exist at the regional level, they are well positioned to tailor education and action for conserving and restoring biodiversity within a given ecosystem, taking the given local species into account. Because many action plans for biodiversity conservation and education on biodiversity exist at the national level, these plans are necessarily broad in scope, often trying to address conservation across a number of different habitat types and individual species which are all facing threats due to a number of driving factors. By working at the regional level, RCEs are able to take a more nuanced and contextualised approach to building knowledge bases about given ecosystems and organisms, and translating this knowledge into capacity-building and training on actionable conservation measures for communities in a given region.

While RCEs designed ESD projects to address all of the Sustainable Development Goals (SDGs) during the Global Action Programme (GAP) on ESD led by UNESCO between 2015 and 2019, approximately 25% of all ESD projects conducted within the RCE Global Network had a focus on education to conserve terrestrial biodiversity (Goal 15 – Life On Land). During the same time period, approximately 13% of all ESD projects within the network had a focus on education to conserve marine biodiversity (Goal 14 – Life Below Water). This predominance of ESD projects to enable local biodiversity conservation has led to the creation of a plethora of unique teaching strategies, modes of engagement, and implementation activities that offer insights into what education to protect the biosphere can entail. By bridging formal and non-formal education, RCEs have created regionally contextualised and cross-sectoral approaches to education on biodiversity conservation in ecosystems and communities around the globe. And these projects are as diverse as the habitats and organisms that they seek to protect.

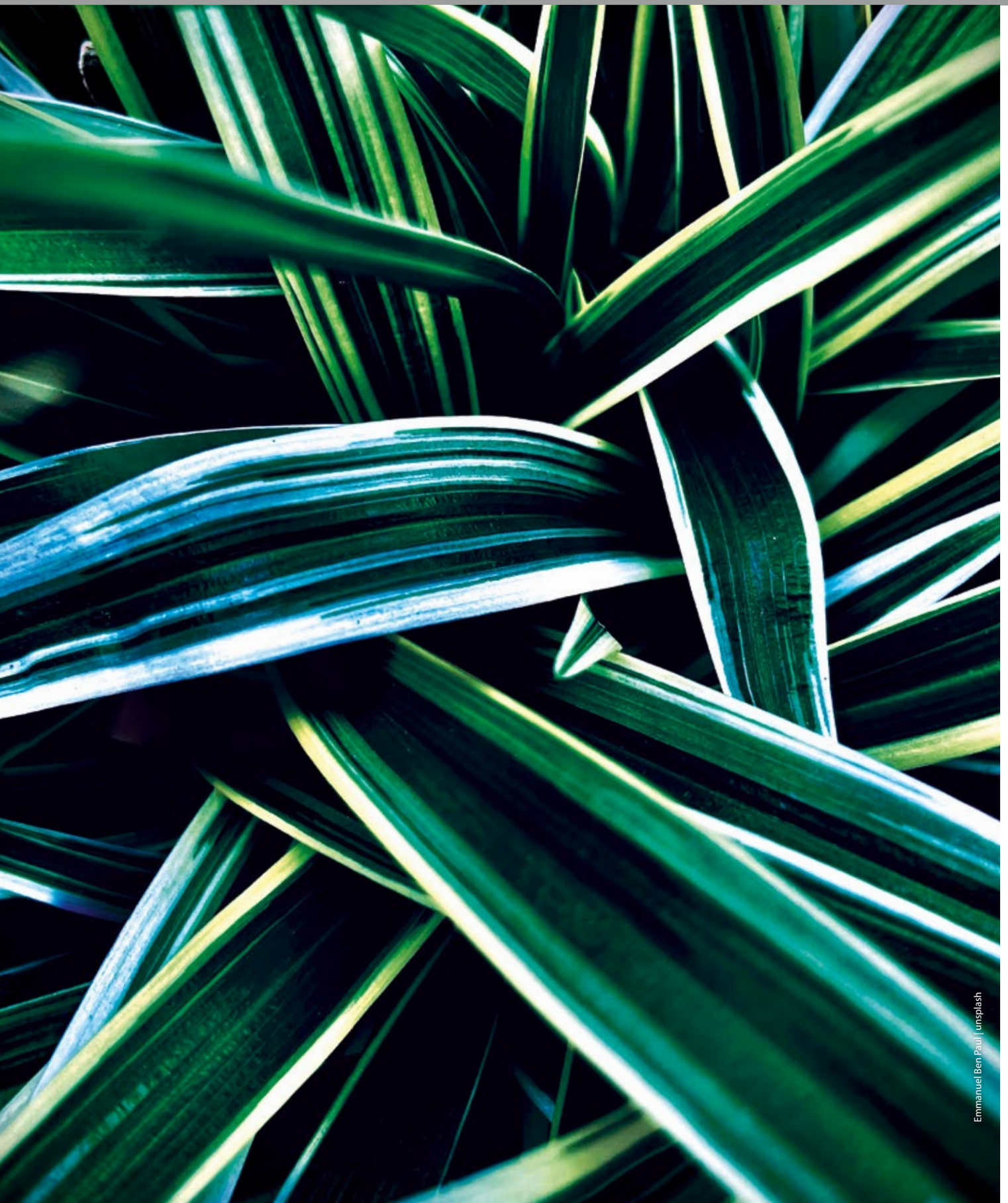
The impact of infrastructure projects on freshwater ecosystems takes centre stage for ESD activities from RCE Greater Western Sydney in Australia and RCE Curitiba-Paraná in Brazil. In Greater Western Sydney, the RCE educates community members on biodiversity monitoring techniques to assess the health of the Hawkesbury-Nepean River amid increasing urbanisation, with attention to population distribution of the iconic platypus *(Ornithorhynchus anatinus)* as a key indicator species. In Curitiba-Paraná, the development of the Itaipu Binacional hydroelectric powerplant in the Paraná River has altered the distribution of native freshwater stingrays throughout the watershed, bringing riverside communities into contact with the rays and creating human-wildlife contact which did not exist before. Here, the RCE works to educate these communities on how to minimise and manage human-wildlife contact, protecting people and rays.

The conservation of vascular plant species is the focus of ESD activities from RCE Zaria in Nigeria and RCE Helsinki Metropolitan in Finland. Bordering where the Sahara desert meets the Sahel, native plant species around Zaria face threats on two fronts – from the loss of soil nutrients due to desertification, and from the loss of habitat due to urban sprawl. RCE Zaria trained local youth to monitor the distribution and health of native plants such as henna *(Lawsonia inermis)*, shea *(Vitellaria paradoxa)*, and baobabs (*Adansonia digitata*) in order to create a Geographic Information System (GIS) database to allow for habitat design in conjunction with urban planning. Local youth were also trained as community educators to teach other community members about the importance of native plants in preventing soil erosion, providing economic resources, and offering shade. In Helsinki, the RCE worked in the school system to bring native plants into the schoolyard, providing more habitat for local species as well as increasing awareness of native biodiversity for the students. When habitat could not be brought into the schoolyards, schoolyards were brought into habitats, with students learning about southern Finland's mixed forest biome through fieldtrips to better understand applied conservation in the area's parks.

The restoration of mangrove ecosystems is the predominant concern of ESD activities from RCE Sundarbans in Bangladesh and RCE Cebu in the Philippines. Within the mangrove forest of the Sundarbans, the RCE addresses habitat destruction for aquaculture by working with local Indigenous communities to create training programmes on Community Based Mangrove Agro-Aqua-Silvi-Culture (CMAASC) as an alternative to resource-intensive commercial aquaculture. These training modules allow for local farmers to still provide for themselves while better protecting the region's biodiversity. Along the coastal mangroves of Cadiz City in the Philippines, RCE Cebu works with the inhabitants on reforestation efforts for mangroves in the face of increasingly severe tropical cyclones. The RCE not only designed reforestation training programmes for local residents and local schools, but worked with local community members to design education programmes on how to supplement local aquaculture and fisheries activities with agriculture so as not to put pressure on the mangrove ecosystem as it regenerates.

Setting the Scene

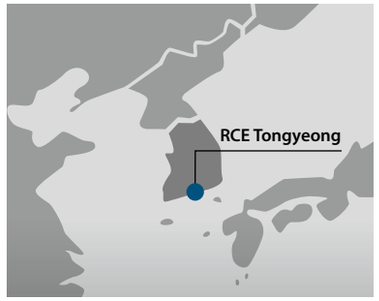
The projects featured in the following publication are not a summation of all of the ESD work on biodiversity conservation by RCEs. Like previous publications on the works of the RCE Global Network, they are an assemblage of best practices showcasing a wide range of education approaches to enact solutions to challenges in sustainable development around the globe. The pressing nature of the Anthropocene extinction makes the works featured here vital blueprints for how other regions can construct responses to protect species, habitats, and ecosystems within their communities. These approaches are unique in that they offer a new way of conceptualising conservation education, where conservation of the biosphere underpins other regional development initiatives such as health care and economic development, as opposed to siloed traditional approaches to regional development that conceptualise human society as operating apart from nature. By using systemic thinking embedded within an ESD approach to learning, these RCE projects offer insights into how educators can not only build awareness of the biosphere among learners, but protect it as well.

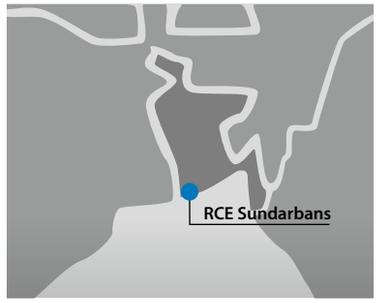


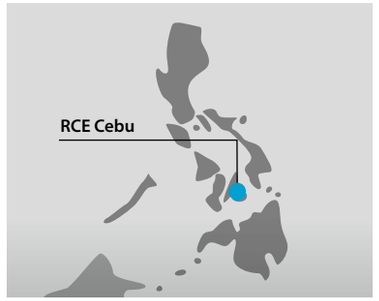
Emmanuel Ben Paul | unsplash

Chapter

Asia-Pacific







Forest Education: Participants taking a walk in the forest and learning about the beauty of nature in the Forest Programme.

Explore Sejahtera Forest: Empowering Learners to Protect Local Biodiversity

RCE Tongyeong

Situation

Tongyeong is a small coastal city with a population of 140,000 located in the province of Gyeongsangnam-do on the southern coast of South Korea. The region has a humid and temperate coastal climate, with broadleaf evergreen forest. Surrounded by more than 570 islands along its coast, the city is known for being a beautiful tourist and recreational city. It is also known as a hometown for the arts, where many famous artists from various fields such as music, literature, and art have been born and practiced their artistry. In 2016, it was also designated as a music city by UNESCO. Most of the working population is engaged in fisheries or tourism, with the elderly population steadily increasing like in many regions of South Korea.

Issue/s

Since the late 1990s, shipbuilding has been the predominant industry in Tongyeong, but now it is declining due to the structural changes within the industry. With a changing job market, the region now must focus on creating sustainable jobs, while simultaneously dealing with a growing elderly population and subsequent decrease of young people within the city's population. Due to several generations of adults primarily living in industrialised landscapes and working on industrial activities, knowledge about and connection to natural landscapes and the species inhabiting them has been somewhat limited, a phenomenon seen in many highly industrialised societies. This means that most residents of the region are not aware of what threats local biodiversity faces and what actions they can take to help protect it. Since the creation of the Sejahtera Forest, interest in ESD on topics like biodiversity has increased for children, adolescents, and their parents, but access to ESD resources by the general public is still limited.

Ocean Education: Participants collecting rubbish and observing sea creatures in the Marine Programme.

Region: Asia-Pacific

Country: South Korea

SDG(s): No Poverty, Quality Education, Affordable and Clean Energy, Responsible Consumption and Production, Climate Action, Life Below Water, Life on Land

Theme(s): Curriculum Development, Ecotourism, Forests/Trees, Plants & Animals, Waste

Target audience(s): Primary, Community

Ecosystem(s): Coastal, Forest

GAP / ESD for 2030 Priority Action Area(s): 2, 5

Language(s) of project: Korean and English

Contributing organisation(s):
- Tongyeong City Government
- Education Office of Tongyeong
- Education Office of Gyeongsangnam-do Province

Linkages to education and/or sustainable development policies:
- MOU between RCE Tongyeong and Gyeongsangnam-do Provincial Office of Education (subnational)

Duration of project: April 2015 – ongoing

Responses/Actions Taken

The goal of this RCE project is for learners to consider how much they themselves impact on both the natural environment's and society's sustainability through participating in a series of short-term activities. Through these activities, students learn what problems and issues for sustainable development exist, why these problems exist both in a global and local context, and critically, how to be an actor at the local level for a sustainable future.

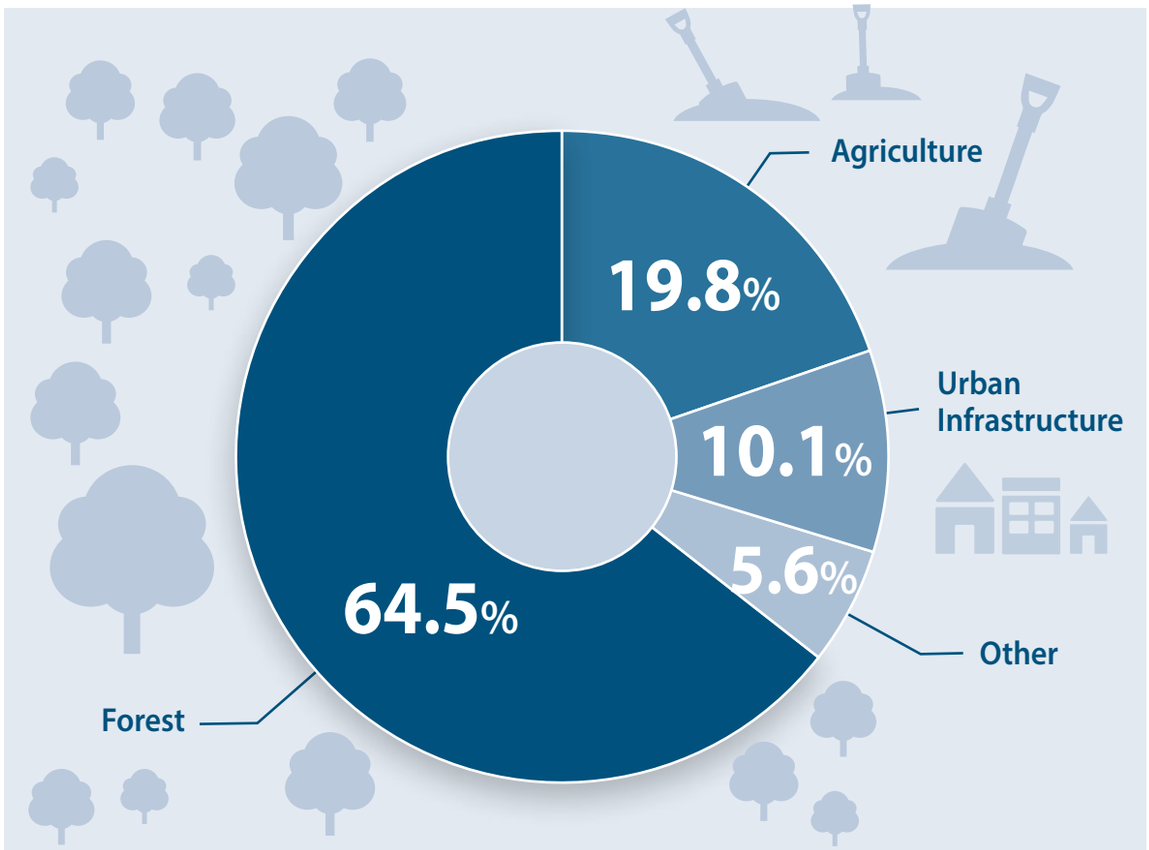
The Eco Study Trip consists of five different programmes that connect with the SDGs and allow anyone who is not familiar with ESD to learn through experiential activities and playing. In the Marine Programme, participants learn about plastic pollution in the world's oceans and how this pollution impacts marine wildlife both globally and locally. The Marine Programme connects local action to this gained knowledge by having participants pick up trash along the local coast, making observations of what type of trash appears most frequently, and exploring how it got there and which species it could impact, such as the finless porpoise (*Neophocaena phocaenoides*), green sea turtle (*Chelonia mydas*), and leatherhead sea turtle (*Dermochelys coriacea*). The Forest Programme walks participants through Sejahtera Forest itself, and provides lessons on local plants and animals such as native wild flowers like the *pungnan* (*Vanda falcata*) and native birds like the Eurasian eagle-owl (*Bubo bubo*), including why these species are vulnerable or endangered, and what actions local residents can take to help protect them. The Forest Programme also teaches about how the forest's trees and other vegetation help to purify the local freshwater sources and prevent soil erosion, again providing actions for participants to protect the forest. At the end of the Forest Programme, participants get to experience dyeing hand towels with natural dyes made from local plant species. The Climate Change Programme seeks to educate participants about how local action can impact wildlife in far off locations, teaching them what types of temperatures, environments, and resources polar bears like and dislike, and indirectly experiencing the impact of declining glaciers through games. The Sunlight Programme teaches how human development needs can be met through renewable energy, which does not contribute to climate change which harms many species and habitats as well as human societies. The participants experience the eco-friendly facilities inside the centre and use solar cookers to make popcorn. Finally, the Water Programme is to learn about the inequality of water resources, exploring the situation by venturing from water-rich to water-starved areas in the area.

Results

Since 2015, over 18,000 learners have participated in this project. Every year, about 5,000 students visit Sejahtera Forest to learn the about the philosophy and actions of ESD, and take these lessons on learning to live and work sustainably with them upon leaving. In 2016, by MOU with the Gyeongsangnam Provincial Office of Education, the RCE Tongyeong Sejahtera Forest was designated as an eco-study trip institution for third grade elementary school students in Gyeongsangnam province. In 2018, it was certified as an effective environment education programme by the Ministry of Environment, Republic of Korea. Through this eco-study trip in the Sejahtera Forest, which is designed to allow human, nature and all animals to coexist, learners have recognised that the human society has currently developed unsustainably. They are able to learn that nature is home to not only humanity but all creatures, as well as why all nature – including the forests and seashores visited – are so important for people and all life on Earth. These participants are now defending forests, investigating their role in an unsustainable society, exploring the products that they use, and learning sustainable lifestyles. The students and teachers alike adopt the philosophy of the Sejahtera Forest in their own school class. They keep practising the sustainable lifestyles they learned at Sejahtera Forest in their school, work, and home environments. It transforms these classes and hopes through ESD, to spread sustainable development beyond the classroom to the community.

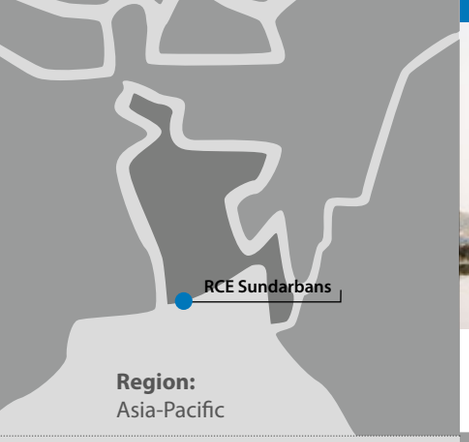
Energy Education: Participants using the seesaw, and learning about eco-energy in the process.

Figure 1. Land Use by Category in Tongyeong City (2018). (Source: Tongyeong City Government).



Actions to Take:

This project is designed to recognise the importance of collective responsibility to address global challenges such as biodiversity loss and climate change. While much focus of sustainable development is given to structuralism, it is important to educate and empower learners through concrete collective action as well.



Region:
Asia-Pacific

Country:
Bangladesh

SDG(s):
Quality Education, Responsible Consumption and Production, Climate Action, Life Below Water, Life on Land

Theme(s):
Disaster Risk Reduction, Forests/Trees, Plants & Animals, Traditional Knowledge

Target audience(s):
Community

Ecosystem(s):
Coastal, Forest, Wetlands

GAP / ESD for 2030 Priority Action Area(s): 5

Language(s) of project:
English & Bangla

Contributing organisation(s):
- Unnayan Onneshan
- University of Dhaka
- Koyra Bonojibi Bohumikhi Unnayan Samity (Koyra Forest Dependent Peoples' Cooperative)
- Horinagar Bonojibi Bohumukhi Unnayan Samity (Horinagar Forest Dependent Peoples' Cooperative)
- Abdibasi Munda Unnayan Samity (Indigenous Munda Cooperative)

Duration of project:
November 2017 – November 2018

A CMAASC (Community Based Mangrove Agro-Aqua-Silvi-Culture) Farm in the Sundarbans.

Chapter Asia-Pacific

Biodiverse Adaptation to Climate Change through Traditional Knowledge and Customary Sustainable Use

RCE Sundarbans

Situation

The Sundarbans are located at the great delta of the Ganges, Brahmaputra, and Meghna (GBM) rivers at the edge of the Bay of Bengal and is the largest contiguous single-tract mangrove ecosystem in the world. The Sundarbans is not only confined to Bangladesh but a significant part of it lies within the state of West Bengal in India. The Bangladesh part comprises 6,071km^2 (62% of the total area) in the south-west of the country and constitutes 39.5% of the total forest area of Bangladesh. The region experiences a warm tropical climate with high rainfall with the surrounding delta area having a low elevation above sea level. The Sundarbans was recognised as a Natural World Heritage Site in 1997 by UNESCO and as a Ramsar Site as a wetlands ecosystem of international importance. Various types of ecosystems (forest, coastal, and wetlands) make the Sundarbans home to uniquely adapted aquatic and terrestrial flora and fauna. It harbours 334 species of plants including trees, shrubs, herbs, and epiphytes and 448 species of vertebrates including 10 amphibians, 58 reptiles, 339 birds, and 41 mammals (see figure 2 on page 25). There are more than 31 globally endangered species here. Among the 50 true mangrove plant species recorded across the globe, the Sundarbans alone harbours 35 species (*Rahman and Asaduzzaman 2010*) (see table 1). As listed in table 2, one of the forest's iconic animal species is the Royal Bengal Tiger (*Panthera tigris*). Other faunal species include estuarine crocodile (*Crocodylus porosus*), olive ridley sea turtle (*Lepidochelys olivacea*), Ganges River dolphin and Melon-Headed whale (*Platanista gangetica* and *Peponocephala electra*), and molluscs – like the Pacific oyster (*Crassostrea gigas*). Birds such as the mangrove pitta *(Pitta megarhyncha)*, mangrove whistler (*Pachycephala grisola*), brown-winged kingfisher (*Halcyon amauroptera*) and collared kingfisher (*Todiramphus chloris*) make the Sundarbans their home. Spotted deer (*Axis axis*), barking deer (*Muntiacus muntjak*), wild boars (*Sus scrofa*), jungle cats (*Felis chaus*), rhesus macaque (*Macaca mulatta*), and otters (*Lutrapers picillata*) are also found within the region. It is also known to be the largest honey-producing habitat in the country with giant honey bees (*Apis dorsata*). A significant number of people maintain livelihoods by utilising the resources in the mangroves and thus the ecosystem provides a unique hotspot for both biodiversity conservation and sustainable resource use. This project has been implemented at Koyra Upazila (sub-district) in the Khulna district of south-western Bangladesh. There are four administrative ranges of Sundarbans in Bangladesh, and this project is situated in the Khulna administrative range.

Table 1. Most prominent mangrove tree plant species in the Sundarbans.

Mangrove plants	Species name
Sundari	*Heritiera fomes*
Gewa	*Excoecaria agallocha*
Baen	*Avicinnia officinalis*
Passur	*Xylocarpus mekongensis*
Keora	*Sonneratia apetala*
Goran	*Ceriops decandra*
Ora	*Sonneratia caseolaris*
Hental	*Phoenix paludosa*
Golpata	*Nypa fruticans*

Table 2. Selection of fauna in the Sundarbans.

Mammals	Species name
Royal Bengal tiger	*Panthera tigris*
Ganges River dolphin and Melon-Headed whale	*Platanista gangetica and Peponocephala electra*

Birds	Species name
Brown-winged kingfisher	*Halcyon amauroptera*
Collared kingfisher	*Todiramphus chloris*

Reptiles	Species name
Estuarine crocodile	*Crocodylus porosus*
Olive ridley sea turtle	*Lepidochelys olivacea*

Issue/s

The Sundarbans of Bangladesh, known as the lung of the country, now can be identified as an ecologically vulnerable area in terms of degradation of its biodiversity. Over the last few decades, it has been experiencing major ecological and

A panoramic view of a CMAASC (Community Based Mangrove Agro-Aqua-Silvi-Culture) in the Sundarbans.

physiographical changes, with many of its resources being lost or degraded due to both human interventions within the forest, as well as climatic change impacting the region. Sea level rise and several natural disasters, i.e. cyclones, tidal upsurge, floods, and salinity intrusion caused by climate change, have had particularly damaging impacts on the forest and wetlands. The major anthropogenic causes of degradation within the forest are illicit destruction of forested areas due to the conversion of forestland into agriculture and conversion of wetlands and coastal areas into aquaculture for shrimp cultivation. The poaching of animal species is also an ongoing problem impacting the region's wildlife.

Responses/Actions Taken

This RCE project was designed to connect diverse knowledge systems and then apply them sustainably in a traditional knowledge-based cultivation method, innovated by the Indigenous Peoples and Local Communities (IPLCs) of the region. This method utilises the cultivation of local floral [Goalpata (*Nypa fruticans*), Goran (*Ceriops tagal*), Keora (*Sonneratia species*), Hargoza (*Alanthus ilicifolius*) and Baen (*Avicennia species*)] and faunal [tengra (*Mystus tengara*), baila (*Awaous guamensis*), tilapia (*Tilapia nilotica*)] species as a response to the impacts of climate change and other anthropogenic pressures on the Sundarbans. Specifically, this project aims to teach the aquaculture sector an alternative practice to commercial shrimp cultivation. This alternative practice is called Community Based Mangrove Agro-Aqua-Silvi-Culture (CMAASC). It not only provides resources for IPLCs, but acts as a mechanism to adapt to damages and vulnerabilities caused by the changing climatic conditions through conservation of native biodiversity. The RCE team consulted IPLCs to form a methodological toolbox. First, the RCE team conducted a Participatory Vulnerability Assessment (PVA) to assess the situation of local floral and faunal species, in order to see which species could be harvested sustainability in a CMAASC system and which needed strict protection. From this step, specified sustainability indicators for assessing CMAASC practices were developed based on the PVA. The RCE team then undertook a cost-benefit analysis for using the proposed CMAASC system as opposed to conventional shrimp aquaculture, and then prepared an inventory of CMAASC practices that can be improved and adapted using both traditional and modern scientific knowledge. Education and training activities serve as the keystone for promoting these practices at a broader level with emphasis on participatory processes in generation of knowledge on application of endogenous, ecosystem-based solutions. These activities have been undertaken among the IPLCs in the project area through workshops, meetings and campaigns. For this, a specific training module on CMAASC, case studies, handouts and a PowerPoint presentation on CMAASC, as well as an inventory of traditional knowledge and customary sustainable practices have been developed. The Indigenous People's Cooperatives ensured equal representation of women and men in all activities. As a result, women were able to voice their insights and concerns, empowering both women and men involved in the process.

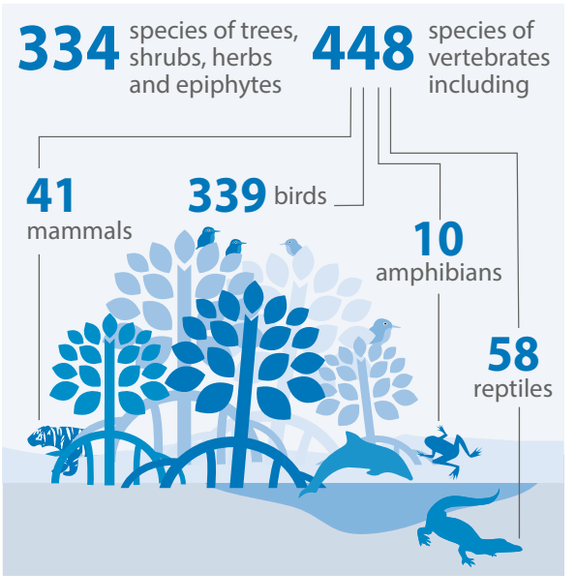
Results

The project has exhibited that CMAASC – a mixture of traditional and scientifically-based cultivation of mangrove faunal and floral species – is more profitable for IPLCs and has less environmental impacts compared to commercial shrimp culture, which has caused habitat degradation and biodiversity loss. Commercial Shrimp (CS) culture increases salinity in soil (in farmland and in adjacent lands). Ponds used in CS exhaust usefulness within three to six years of construction – leading to destruction of mangroves to make room for more ponds. Chemical fertilisers and insecticides used in CS causes pollution, eradicates natural mangrove vegetation, and pollutes aquatic resources. On the contrary, CMAASC does not need saline water, and therefore causes no salinity intrusion. CMAASC activities uses homestead adjacent fallow lands and therefore there was no conversion of forest lands into cultivation lands. In addition, chemical fertiliser or insecticides are not used in CMAASC.

Aqua culture in a CMAASC (Community Based Mangrove Agro-Aqua-Silvi-Culture) plot.

This CMAASC system reduces the increasing anthropogenic pressures of CS, creating alternative livelihoods for the local people who are dependent on the biodiversity of the Sundarbans. The Indigenous Peoples Cooperatives have mobilised the traditional forest users or Banajibis and provided a space for discussion, consultation, planning, and claiming of their rights. Moreover, the Indigenous Peoples Cooperatives have also become platforms for inspiration for innovative options, such as locally available climate adaptive economic activities. The project enhanced community capacity and knowledge to utilise the natural resources from the mangrove forest based on traditional knowledge, and increased the resiliency of the community against climate change. These communities realise that biodiversity resources are declining and their survival depends on the existence of the Sundarbans and its biodiversity. It is often difficult to achieve sustenance solely depending on the forest for their livelihood. Therefore they are now cultivating fish, crab, and golpata, using this knowledge as an alternative to resource collection and working to protect the biodiversity and collect resources using traditional sustainable techniques. For example, the practice of leaving behind one-third of a beehive and making sure no young bees are killed when collecting honey so the hive can regenerate has been re-established.

Figure 2. Aquatic and terrestrial flora and fauna in the Sundarbans.
(Source: Titumir, Afrin, and Islam 2020).



The research undertaken at the beginning of this project demonstrates that the teaching of traditional knowledge systems can significantly contribute to the sustainable management of biodiversity in a changing climate, both within the protected areas system and potentially in other areas' conservation measures, if they are given a chance and are supported by government and non-government agencies.

Actions to Take:

It is important to work with synergies when possible in ESD initiatives. Indigenously-innovated adaptation through traditional knowledge on biodiversity and customary sustainable use can be used not only to conserve biodiversity, but also promotes sustainable production and acts at mitigating climate change – addressing two additional SDGs. It is also critical to involve women and Indigenous and local communities as key actors in the design and implementation of any such project.

The mangrove site and its restoration.

Chapter Asia-Pacific

Climate Action through Preservation of Indigenous Knowledge for Mangrove Protection and Conservation

RCE Cebu

Situation

Cadiz City lies on the northern coast of the province of Negros Occidental in the Philippines. Mangrove ecosystems form the backbone of coastal communities in the region with many people relying on marine resources for both food and as a source of livelihood. Most of the people in the community are fisherfolks with houses located near the seashores that are vulnerable to coastal storms, storm surges, and strong winds. When a mangrove ecosystem is healthy, endemic marine organisms flourish in their shallow waters, which helps to augment the fisherfolk community's source of livelihood and foods. The mangroves also help regulate wave surges and serve as a windbreaker during typhoons. In addition, they serve as a temporary habitat for a diverse assortment of waterbirds which come to feed in the area during their migration seasons (see table 3).

Table 3. Migratory waterbirds species present in the Cadiz City mangrove forest.

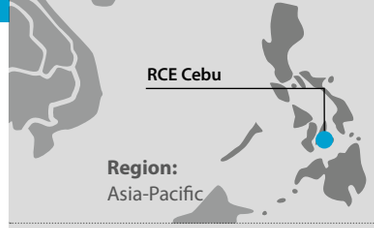
Migratory bird species	Species name	Conservation status
Red-necked grebe	*Podiceps grisegena*	Least Concern
Eastern great egret	*Ardea alba modesta*	Least Concern
Chinese egret	*Egretta eulophotes*	Vulnerable
Little egret	*Egretta garzetta*	Least Concern
Beach stone-curlew	*Esacus magnirostris*	Near Threatened
Black-winged stilt	*Himantopus himantopus*	Least Concern
Pied stilt	*Himantopus leucocephalus*	Least Concern
Little ringed plover	*Charadrius dubius*	Least Concern
Eastern osprey	*Pandion cristatus*	Least Concern
Javan pond heron	*Ardeola speciosa*	Least Concern
Common redshank	*Tringa totanus*	Least Concern
Wood sandpiper	*Tringa glareola*	Least Concern
Common moorhen	*Gallinula chloropus*	Least Concern

Issue/s

The mangrove forests on the coast of Cadiz City were severely impacted by Typhoon Haiyan in 2014, with much of the forest and infrastructure along the coast destroyed by the storm. It quickly became clear that the coast would need to be rehabilitated through conservation efforts, including re-planting trees to re-establish the forest. The provisioning of food sources and livelihood for the fisherfolk community also posed a very challenging scenario after the typhoon, as the mangrove forest area provided the habitat for most of the marine organisms harvested as food sources and for market. The local community were very eager to rehabilitate the mangrove area. Thus, the Philippine Normal University Visayas collaborated with the community and other partners in the RCE to establish conservation initiatives centered around tree plantings, as well as initiatives on food preparation and backyard gardening, to help households augment their traditional sources of food and income.

Responses/Actions Taken

A rehabilitation programme for the coast was launched which focused on the replanting of the mangrove species *Avicennia marina* – commonly known as the grey mangrove. This programme was led by RCE Cebu, and worked with local government units as well as the local communities to create trainings and workshops for community members. Topics included how to grow seedlings in a nursery and properly plant and care for trees along the storm damaged coasts. Both men and women were given the same trainings on mangrove reforestation and coastal management. Special attention was given to make sure women from the local community were given opportunities to take management and leadership roles in the planning and implementation of the project. Capacity-building activities were also created among the partners to educate on gardening initiatives and food preparation in order to shift community consumption patterns so that less pressure was put on marine resources while the mangrove forest regrew. Instructional materials as well as a curriculum for pre-service teachers who wanted to teach about mangrove conservation were created through a Reflect-Share-Act framework among the project partners. Additionally, trainings and workshops were offered for in-service primary school teachers to help integrate mangrove conservation into their classroom activities.



Region:
Asia-Pacific

Country:
Philippines

SDG(s):
No Poverty, Zero Hunger, Quality Education, Gender Equality, Decent Work and Economic Growth, Climate Action, Life Below Water, Life on Land, Partnerships for the Goals

Theme(s):
Disaster Risk Reduction, Traditional Knowledge, Curriculum Development, Eco-Tourism, Forests/Trees, Plants & Animals, Waste

Target audience(s):
Primary, Community, Teacher Education, Youth (Informal)

Ecosystem(s):
Coastal, Wetlands

GAP / ESD for 2030 Priority Action Areas: 1, 2, 3, 5

Language(s) of project:
English

Contributing organisation(s):
- Philippine Normal University Visayas
- Purok Kakahuyan Small Fishermen Association – PKSFA (Fisherfolk organisation)
- Barangay Council of Barangay Daga, Cadiz City
- Daga Elementary School
- Department of Environment and Natural Resources - Philippines DENR
- City Environment Office
- Department of Agriculture - Philippines
- Philippine Biodiversity Conservation Foundation Inc. (PBCFI)

Linkages to education and/or sustainable development policies:
- Commission on Higher Education Memorandum Order (CMO #52, Series of 2016)
- Philippine Normal University, Board of Regents (BOR) #1865 series of 2012

Duration of project:
March 2014 – ongoing

Fisher folks spotting various common waterbirds at the mangrove rehabilitation site, sharing their local names and how often these birds visit the place. They have named the resident birds differently from migrating birds.

Results

Upon implementation of the training programmes, over 1,000 healthy young mangrove trees (*Avicennia marina*) have been planted to add to the 200 adult mangrove trees that survived the typhoon. The fisherfolk community has continued to plant and in some cases re-plant mangrove seedlings within the rehabilitation site. They have continued to practice backyard gardening and different types of food preparation to conserve the marine species left in the re-emerging mangrove forest.

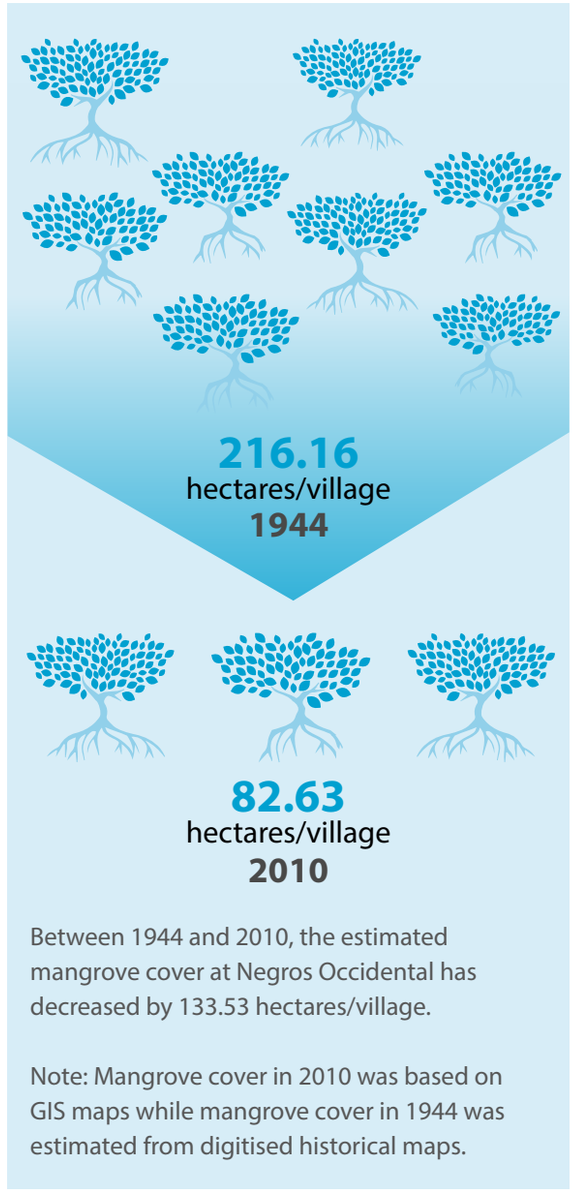
Local marine species that were extirpated due to the destruction of the mangrove forest in 2014, such as peanut worms (*Phylum Sipuncula*), blood clams (*Anadara granosa*), button top snails (*Umbonium vestiarium*), and razor clams (*Pharella acutidens*) have all re-established populations in the marine environment as of 2021. These species are now able to be harvested again in sustainable numbers by local community, and once again provide a food source for visiting waterbird species during their migration. By 2020, 68% of migratory waterbird species that used the mangrove forest as a feeding ground pre-2014 had returned to the site.

The curriculum that was developed for pre-service teachers has now been included in the university general education course as a capstone activity for teacher candidates, and workshops on mangrove conservation offered to both community members and teachers continue to be immensely popular. In addition, the content-based instructional materials developed by in-service teachers are used to enhance reading skills in the primary level.

Mangrove trees (*Avicennia marina*) on their 4th year healthily growing at the rehabilitation site.

Women joining with fisherfolks in searching for endemic species flourishing in the rehabilitated mangrove site.

Figure 3. Mangrove Cover in Negros Occidental. (Source: Seriño, et. al 2017).



Between 1944 and 2010, the estimated mangrove cover at Negros Occidental has decreased by 133.53 hectares/village.

Note: Mangrove cover in 2010 was based on GIS maps while mangrove cover in 1944 was estimated from digitised historical maps.

The mangrove rehabilitation site as of now.

Actions to Take:

When working with local communities on conservation initiatives, it is imperative these communities be approached as sources of knowledge, not just as citizens to be educated. Oftentimes, local communities have knowledge of best practices to protect native species and ensure ecosystem services are sustainable, in addition to knowledge on supplementary economic activities that can take pressure off native biodiversity.

Region:
Asia-Pacific

Country:
Australia

SDG(s):
Quality Education, Clean Water and Sanitation, Life Below Water, Life on Land

Theme(s):
Ecotourism, Plants & Animals

Target audience(s):
Community, Higher Education

Ecosystem(s):
Peri-urban, Fresh Water

GAP / ESD for 2030 Priority Action Areas: 1, 5

Language(s) of project:
English

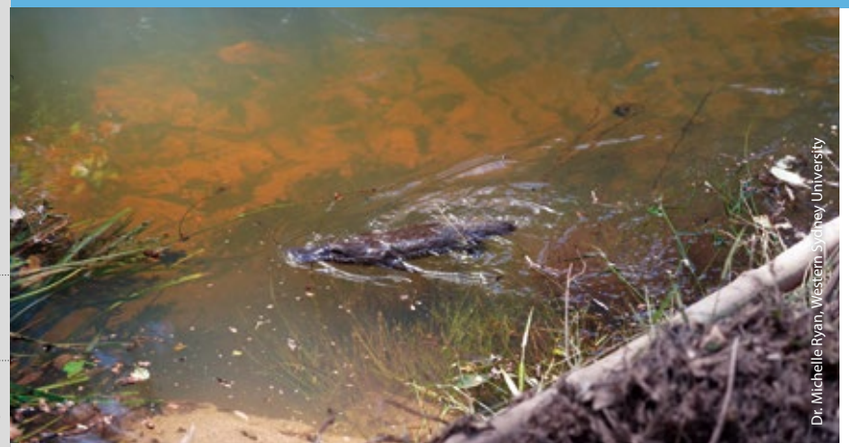
Contributing organisation(s):

Platypus project:
- Western Sydney University, School of Science
- Cattai Hills Environment Network

Members of the Hawkesbury-Nepean Riverkeepers Waterkeeper Alliance (HNRWA):
- Western Sydney University (comprising RCE Greater Western Sydney)
- Greater Sydney Local Land Services
- Greater Sydney Landcare Network (GSLN) with Streamwatch and GSLN member groups: Hawkesbury-Nepean Landcare Network, Cattai Hills Environment Network and Hawkesbury Environment Network

Linkages to education and/or sustainable development policies:
- Environment Protection and Biodiversity Conservation Act, 1998
- NSW Threatened Species Conservation Act 1995
- NSW Fisheries Management Act, 1994

Duration of project:
June 2018 – ongoing
(Project planning and discussions commenced in 2018. The official sampling period/citizen science project commenced in February 2020. It is an ongoing initiative.)



A platypus spotted swimming/foraging in the Hawkesbury-Nepean River at Yarramundi in the upper catchment.

Chapter Asia-Pacific

Hawkesbury-Nepean Riverkeepers Waterkeeper Alliance: Supporting Citizen Science Platypus Research and Conservation

RCE Greater Western Sydney

Situation

Greater Western Sydney is located in the western part of Sydney and faces distinctive sustainability challenges associated with an increasing population and rapidly developing urbanisation. The Hawkesbury-Nepean River is the region's most important and largest river system encircling the Sydney basin. It provides 97% of the region's fresh drinking water, supports the agriculture and aquaculture industries as well as tourism and recreation sectors, and provides a complex ecosystem for a multitude of plant and animal species including the iconic Australian platypus (*Ornithorhynchus anatinus*). As a result of increasing development, the Hawkesbury-Nepean River is under increasing pressure which has seen the river's health decline. In 2020 the Hawkesbury-Nepean Riverkeepers Waterkeeper Alliance (HNRWA) was reformed under the RCE Greater Western Sydney network with a mission to work collaboratively towards *'a healthy, liveable, swimmable, fishable river for all'*. Within the Hawkesbury-Nepean River catchment there are over 60 species of frogs and 50 species of finfish, nine of which are introduced. Seven species of native frogs, seven native fish species, and two dragonfly species are classified as a threatened species *(NSW DPI 2006)*.

Issue/s

The platypus is one of Australia's most elusive creatures. Platypus are listed on the IUCN Red List as 'Near Threatened', but their mysterious behaviour makes their distribution and abundance hard to determine. With the rapid expansion of Western Sydney to accommodate population growth causing habitat loss and ecosystem degradation, combined with the recent climate impacts of drought and bushfires in 2019/20, urban platypus populations are under increasing threat. The population of platypus in Sydney is not well studied, not well documented, and poorly acknowledged by the larger community. This citizen science project was conducted in Western Sydney's north-west sector, close to a new development site designed to add 33,000 new homes to accommodate around 92,000 residents. The study aimed to confirm urban platypus presence and then build community knowledge, increase environmental awareness, build a media campaign, and take steps to assist in habitat protection in the Hawkesbury-Nepean catchment.

Responses/Actions Taken

Funded under the local government Communities Environment Program, a research team from Western Sydney University and Cattai Hills Environment Network (CHEN), both key members of the HNRWA, trained volunteer citizen scientists and students, to collect samples from the Cattai catchment from June 2020 - June 2021. The aim was to determine the presence of platypus, selected as an umbrella species for waterway health, and as a means for community buy-in due to their iconic status. By using eDNA detection technology – an innovative, non-invasive

A Western Sydney University student undertaking sampling in the local creek in the Hawkesbury-Nepean catchment.

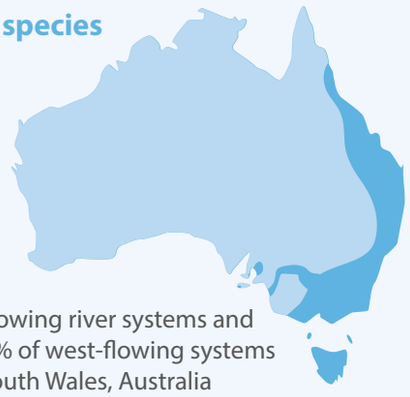
sampling technique that analyses a small water sample for traces of platypus DNA - the group found evidence of platypus habitation in the local streams and creeks, giving credibility to years of anecdotal reported sightings from members of the community.

The HNRWA achieved global recognition from the international Waterkeeper Alliance, a global movement of community-based organisations employing on-the-water advocates who patrol and protect rivers, in 2011. This original RCE initiative is currently under renewal, with a new collaborative working group. This group is seeking to: fund a Riverkeeper; build a 'Friends of the Alliance' stakeholder network; create a river health report card that combines scientific, social and cultural data; and provide a number of hands-on community citizen science days.

Citizen scientist from CHEN using the eDNA sampling method to detect platypus presence.

Figure 4. Map of platypus species' habitats. (Source: Australian Platypus Conservancy).

Platypus species inhabit:



- All east-flowing river systems and about 80% of west-flowing systems in New South Wales, Australia
- About 80% of river basins in Victoria, Australia
- About 1/3 of river basins in Queensland, Australia*

* River basins containing reliably flowing water bodies

Results

The project has engaged citizen scientists from the local community (facilitated by CHEN), as well as Western Sydney University students, who have undertaken a number of sampling days across 2020–21 and were trained to undertake eDNA samples, contamination control, and habitat assessment. The project is being scaled up and sampling is underway in further reaches of the Hawkesbury-Nepean River across two Local Government Areas. Two undergraduate Western Sydney University students undertook this research as part of their final year research projects in partnership with HNRWA and under the supervision of faculty members.

The project was the first to find the presence of platypus in urban creeks and streams in the Sydney basin in recent years (in the Cattai, and expanded to Yarramundi, Wallacia, Penrith, and the Hawkesbury). It has generated national attention, raising the profile of platypus in our urban waterways and supporting advocacy for conservation as well as mobilising actions for the improvement of the health of the water catchment. Specifically, CHEN has been engaged by Hills Shire Council to write a platypus conservation strategy for the Hills Shire area. New partnerships with key stakeholders have expanded to include Sydney Water, Penrith City Council, and Mulgoa-Valley Landcare. Additionally, a media campaign for sharing the findings has more broadly increased public awareness within the community about the need for conservation measures, including property owners and farmers.

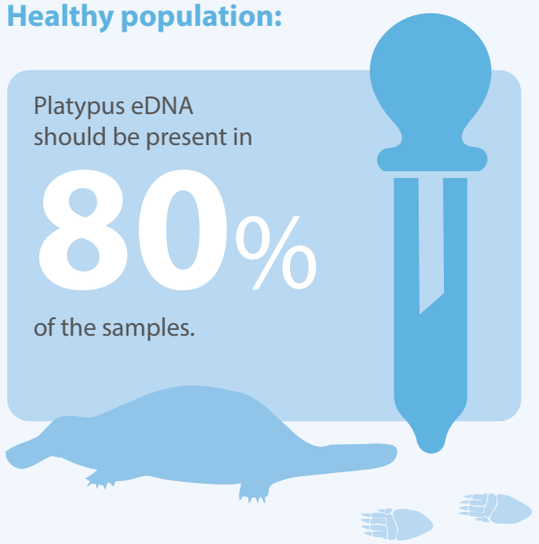
To support this work further, the HNRWA is currently gathering data to produce a 'River Health' report card, and is seeking community contributions through an online questionnaire to help build awareness of the aquatic species living in or around the Hawkesbury-Nepean River, including the platypus. This will be coupled with a community cultural day with our First Nations' community educators and the species names will also be presented in the report card in Indigenous languages. The next planned stage of the project is to look further at the health and movement of these platypus populations and to establish community education and habitat restoration programmes along the river.

Healthy population:

Platypus eDNA should be present in

80%

of the samples.



Surveyed sites:

50%

of samples indicated the presence of platypus (most in or near urbanised areas).

Platypus eDNA was detected at 9 of the 18 sites and 5 out of the 9 waterways surveyed.

Whilst the platypus population is still present, the fact that only 50% is present within the surveyed sites indicates further needs to be done as the urban platypus population is under threat.

More Information:

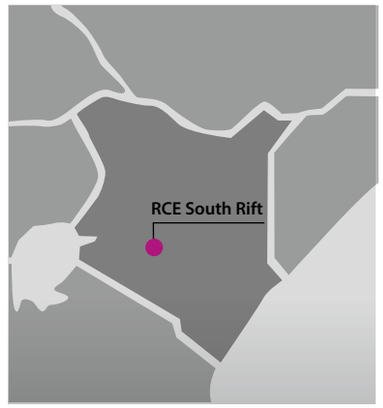
Video: 'You've probably never see one in the wild, but there's platypuses in Sydney's suburbs' (ABC News Australia)
https://www.youtube.com/watch?v=HLc0GYQdLXk

Actions to Take:

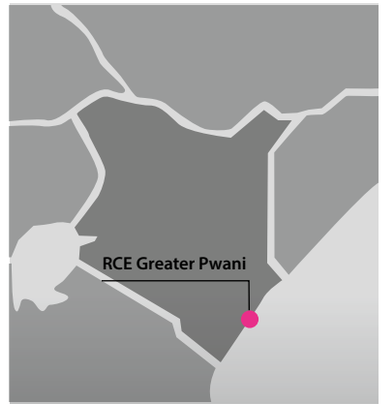
When a water catchment is under pressure from growing urbanisation, it is important that the presence of species like the platypus is acknowledged and monitored, and a plan is put into place to conserve its population. This includes educating the resident population on what measures need to be taken to protect the species. By providing citizen scientists the opportunity to take ownership in collecting data and contributing to the project, it has empowered the community to connect with and become educators and advocates for the conservation and protection of their waterways.

Chapter Africa

Enhancing Understanding of Vegetation Change within an Ecosystem in the Zaria Region



Habitat Rehabilitation through Community Engagement and Action



Evaluation of Land Use Changes and Land Tenure Systems Using Social Tenure Domain Model (STDM) Techniques in the Taita Hills Forest Eco-Region

Stack of firewood of endangered tree species *(Vitellaria paradoxa)* used for cooking.

Chapter Africa

Enhancing Understanding of Vegetation Change within an Ecosystem in the Zaria Region

RCE Zaria

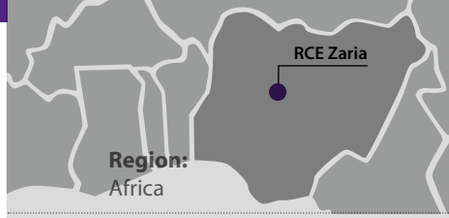
Situation

Zaria is a major city in Kaduna State, within Northern Nigeria's high plains, covering an area of 563km^2. The region is a preferred site for agriculture due to its fertile soil and favourable climate which is divided into two seasons: the dry and rainy seasons. The dry season is usually from November to March, with the temperature at an average of 28^{O}C towards the end of the dry season. The rainy season is from April to October – the daily mean maximum temperature reaches a peak in April and a minimum occurs between December and January. The surrounding landscape is composed mainly of loamy and sandy soils, and the vegetation cover is a tropical savannah bordering the Sahara Desert, characterised by short trees, shrubs, and grasses which are typical for the region. The region had a history of sedentary Hausa settlement, with institutional but pre-capitalist market exchange and farming which predates the rise of the Zazzau traditional state in the region. With a population of over 1 million, most of the inhabitants engage in informal economic activities. Furthermore, the literacy rate is very low despite the fact that the area plays host to over 13 major tertiary institutions in Nigeria.

Issue/s

Like many other cities around the world, the region around Zaria is losing most of its indigenous species of plants and animals to sprawling urbanisation, deforestation, and unsustainable agricultural practices. The rapid rate of urbanisation and the quest for infrastructural development are both major factors of concern (see figure 5 on page 39). The community members, local leaders, and local government officials have little knowledge on tracking this phenomenon which poses a threat to the attainment of SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 15 (Life on Land). More so, there is general paucity of data on endangered species and a lack of effective conservation policy and implementation. Little is also known about how urbanisation threatens various species of plants and animals in the region, particularly the endangered species in the most need of conservation. This absence of information makes it difficult to create policy guidelines for conservation of endangered species in the area, and also makes it difficult to change the communities' attitudes and behaviour regarding the region's flora and fauna.

Community Champion in the process of geo tagging an endangered tree species *(Azadirachta indica)*.



Country: Nigeria

SDG(s): Zero Hunger, Quality Education, Sustainable Cities and Communities, Climate Action, Life on Land

Theme(s): Agriculture, Curriculum Development, Disaster Risk Reduction, Forests/Trees, Plants & Animals, Traditional Knowledge

Target audience(s): Primary, Secondary, Higher Education, Community, Youth (Informal)

Ecosystem(s): Agricultural, Dryland, Grassland, Urban/Peri-Urban

GAP / ESD for 2030 Priority Action Areas: 1, 3, 4, 5

Language(s) of project: English

Contributing organisation(s):
- Ahmadu Bello University, Zaria
- Gifted Hands Secondary School, Zaria
- Domain Academy Sabon Gari, Zaria
- Centre for Development and Advanced Learning (CENDAL), Sabon Gari, Zaria

Linkages to education and/or sustainable development policies:
- National Policy on Environment 1989 (revised 2001)
- National Biodiversity Strategy and Action Plan (NBSAP 1995)
- Kaduna State Forestry Law (2019)

Duration of project: January 2014 – ongoing

Responses/Actions Taken

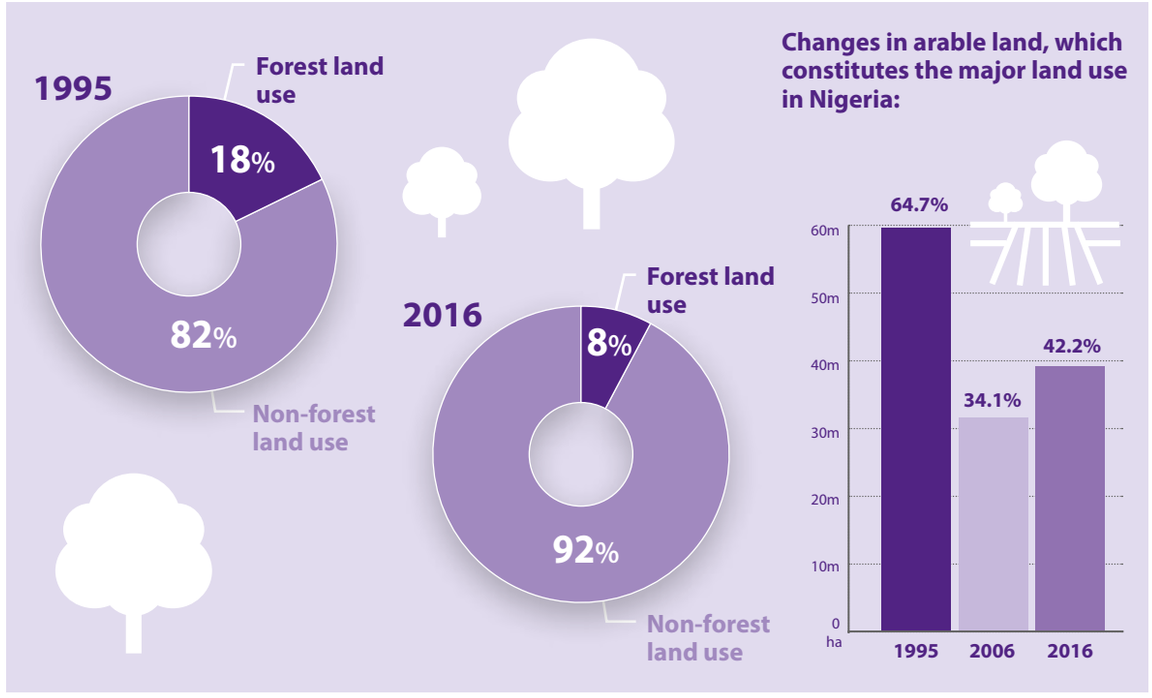
This project was initiated in 2014 with focus on spatiotemporal analysis of vegetation in the region. Analysis of the data allowed the RCE team to create a vegetation index which enabled reliable spatial and temporal comparisons of photosynthetic activity in the areas. This allowed the team to examine where vegetation cover was decreasing and then field investigations at the identified sites allowed the team to understand why it was decreasing in these areas (paving of surfaces, lack of soil fertility due to unsustainable agricultural practices, etc.). From the fast-decreasing vegetation, the team identified and classified indigenous species under threat based on International Union for Conservation of Nature (IUCN) criteria into Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Extinct (EX), which then forms the Zaria Red List of Threatened Species. Youths (Community Champions) within the community were mobilised during site visits to geo tag and provide feedback on location and names of tree species on the list within their locality. This also helped chart the way forward for drafting a policy guide on sustainable use of the environment that ensures the protection of these species, and for proper documentation in accordance with guidelines set by IUCN. This was essential in creating guidelines to protect both endangered species as well as the ecosystem as a whole. Information on rate of vegetation decrease and status of the identified species were made public via an online platform. These results were also disseminated to the community via the RCE website. Other platforms that were utilised for information dissemination include social media groups which the RCE team are active members of. In addition, the RCE team and Community Champions engage with the youths at events and social gatherings like the 'Mai Shayi' (tea shop) joints. The Mai Shayi joint is a popular site for social interactions which foster social integration and knowledge exchange amongst residents and non-residents alike.

A typical Mai Shayi joint (tea shop) where information is readily shared.

Results

The outputs indicate that urbanisation has been reducing the vegetation cover in the region at an average rate of 3.8% annually since 2014, and if urban development is not properly managed, it has the potential to increase to 4.3% annually in the coming years. A total of 15 trainees and 66 participants were involved in the data collection drawn from various districts of Zaria. They learned new knowledge on the pace of depletion of important forest species and the potential implications of losing these species in the region. They were also educated on skills for mapping and advocacy for protection and conservation. It is through this advocacy training that these trainees and participants have greatly upscaled education and public awareness on biodiversity within the region with each one reaching many community members.

Figure 5. Changes in forest land use, non-forest land use, and arable land use in Nigeria. (Source: FAO 2020).



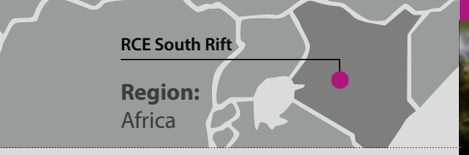
The 10 indigenous species listed in table 4 below were found to be endangered locally. Community members were involved in identifying them and are beginning to appreciate and also take into cognisance the implications of loss of these species. They have also successfully prevented the removal of some of the species for road expansions.

Table 4. Some Endangered Species within Zaria Region.

S/N	English Name	Scientific	Local Neme
1.	Henna	*Lawsonia inermis*	Lállè
2.	Shea	*Vitellaria paradoxa*	Kanya
3.	Neem	*Azadirachta indica*	Dogon Yaro
4.	Large-Grain	*Sorghum bicolor*	Gàmjíí
5.	Baobab	*Adansonia digitata*	Kuka
6.	Chew-Stick Tree	*Anageisus Leiocarpus*	Marke
7.	Black Plum	*Vitex doniana*	Dinya
8.	Kapok	*Ceiba pentandra*	Rimi
9.	Benne	*Sesamum indicum*	Dorawa
10.	Tamarind	*Tamarindus indica*	Tsamiya

Actions to Take:

The method used in determining the changes within the local biodiversity has proven to be cost-effective and provides for real-time monitoring of changes within the environment. The integration of GPS has made it possible to monitor the spatial distribution of species at a wider scale. Most importantly the introduction of other Cellular Automata script has made it possible to forecast future scenarios. For similar projects, it is important to engage youth within a community who can assist with identifying and tagging the location of different local species, and also act as multipliers for knowledge transmission.



Country:
Kenya

SDG(s):
Climate Action, Quality Education, Gender Equality, Affordable and Clean Energy, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life on Land, Partnerships for the Goals

Theme(s):
Ecotourism, Forests/Trees, Plants & Animals, Traditional Knowledge, Waste

Target audience(s):
Community, Secondary, Higher Education, Youth (Informal)

Ecosystem(s):
Dryland, Grassland, Urban/Peri Urban

GAP / ESD for 2030 Priority Action Areas: 2, 4, 5

Language(s) of project:
English

Contributing organisation(s):
- Maasai Mara University
- National Environment Management Authority – Kenya
- Kenya Wildlife Service
- Baruk Yadiym Ecosphere
- Ewaso Nyiro South Development Authority (ENSDA)
- Narok County Government
- National Museums of Kenya (NMK)

Linkages to education and/or sustainable development policies:
- ESD Policy (2017) of Kenya – local, sub-national, national
- Global Environment Outlook for Youth, Africa: A Wealth of Green Opportunities (2019) (Publisher: UN Environment Programme) – international
- Africa Environmental Education and Training Action Plan 2015–2024 – international
- Africa Union's Agenda 2063 – international
- UNFCCC Youth Agenda – international
- UNESCO GAP on ESD – international

Duration of project:
May 2018 – ongoing

Waste water oxidation ponds.

Chapter Africa

Habitat Rehabilitation through Community Engagement and Action

RCE South Rift

Situation

Narok Town is located south east of Kenya's capital of Nairobi in a portion of the Great Rift Valley known as the South Rift, at an elevation of 1,827m above sea level. The landscape around Narok is a tropical savannah, which is also home to the world-famous Maasai Mara Game Reserve which is contiguous with the Serengeti National Park in bordering Tanzania. The town has an estimated population of 40,000 inhabitants. The area is arid and predominated by the Maasai community, which engages in livestock husbandry, agricultural production, trade, and wildlife conservation at the Maasai Mara Game Reserve. The reserve hosts the famous Great Migration – a phenomenon where hundreds of thousands of animals from many different species migrate from the southern Serengeti northwards towards Maasai Mara. It is also recognised as an Important Bird Area, recording a number of different species, including Afro-Palearctic migrant species. However, due to rapid socio-economic development, the area is currently facing environmental issues such as unsustainable consumption patterns and inadequate waste management, and land fragmentation.

Issue/s

While ecotourism has helped the region develop economically, the patterns of development have led to increased land degradation as well as un-planned sub-divisions in the town and outlying regions. New consumption patterns have created more waste than the present waste disposal systems can handle, leading to issues with waste disposal services and sanitation conditions in what was once a pristine environment. Increased demand for energy from a growing urban area has contributed to habitat fragmentation and degradation as communities are still reliant on wood for fuel. This has not only impacted woodlands, but also farmlands with increased erosion due to overharvesting of tree species. Wildlife poaching continues to be a problem, despite the community's dependence on the surrounding wildlife for ecotourism and their efforts to maintain the local ecosystems. Finally, while recent development patterns have resulted in important economic and educational gains, women and girls continue to be marginalised in accessing these new economic and education opportunities.

Responses/Actions Taken

At the beginning of the project, RCE South Rift documented and published on the Maasai community's Indigenous knowledge regarding native floral species. This work contributed to scientific, cultural, and ecological knowledge of the region's medicinal plants and the ecosystem they inhabit. This documentation helped establish a baseline for which conservation and management practices already existed within the community and contributed to promoting health and various Aichi Sustainability Targets. The findings were published in Springer and MDPI, contributing to guiding restoration processes in line with Indigenous knowledge.

Next, training on conservation and management practices were designed to address deforestation in woodland areas throughout the savannah, as informed by the Indigenous knowledge documented. Public awareness activities led by Maasai Mara University in collaboration with the Narok County, Kenya Wildlife Service (KWS), Kenya Forest Service (KFS), the National Environment Management Authority (NEMA), and other private stakeholders were created to educate the

A student on a field excursion on avian conservation.

community on tree species' diversity, threats they face, and their conservation status.

Over 2,000 indigenous trees have been planted in vulnerable woodlands by secondary and university students, civic leaders, and community members from the region, contributing to climate change mitigation and adaptation in addition to biodiversity conservation. Various seed nurseries of commonly harvested plants were also established and the seedlings have been planted throughout the region to reduce pressures on wild populations. RCE South Rift also partnered with various stakeholders to mainstream bee keeping initiatives, providing community members with alternative income generating activities through education and training. These initiatives have contributed to empowering youth, women, and marginalised communities through providing decent jobs while simultaneously reducing pressure on the surrounding ecosystem. Additionally, trainings and public awareness activities were designed on waste separation, waste water treatment, and energy conservation.

Maasai Mara University has also established an orchard within the campus, which contributes to food safety and nutrition for the region. The micro-habitat also hosts diverse birds, insects and related biodiversity. This orchard serves as a living lab for conservation initiatives to help educate students from the departments of Forestry and Wildlife Management, Animal Health and Production, Tourism, and Environmental Sciences. Through its multi-stakeholder partnership, Maasai Mara University has worked with the National Museums of Kenya (NMK) Ornithology Section and RCE South Rift, to educate and empower students on avian species management. Various bird watching and ringing expeditions have been conducted to provide students with hands-on training for conservation management and monitoring. These trainings have increased awareness on avian biodiversity, conservation of their habitats, and promoted sustainable avitourism in the region.

Students studying in a green space within Maasai Mara University.

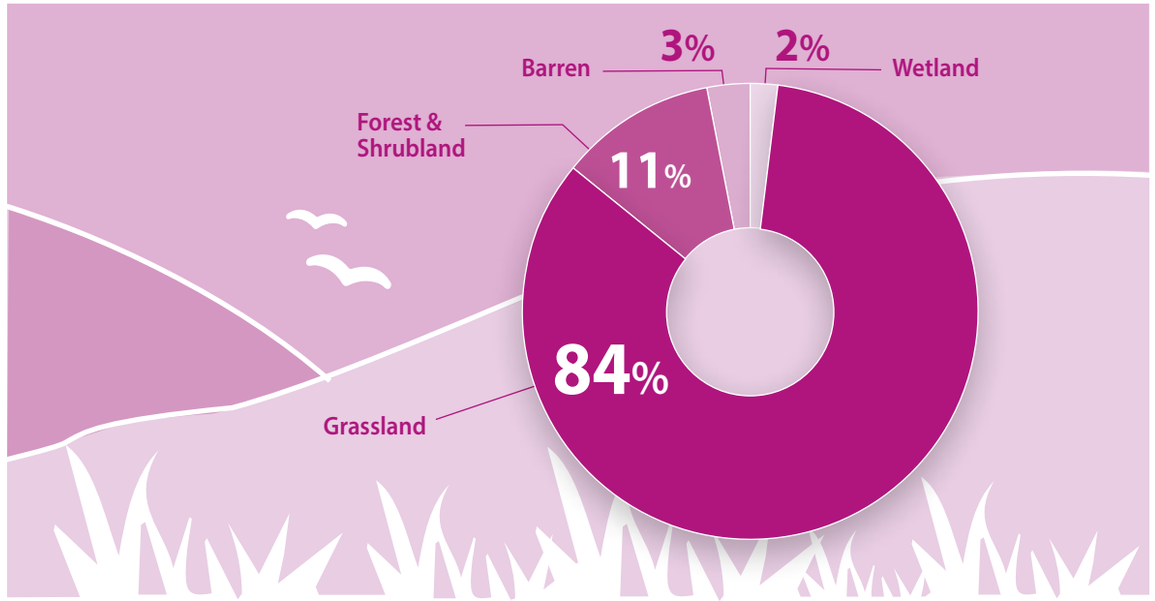
RCE South Rift uses various feedback channel platforms to share the knowledge collected from all of these initiatives to educate and empower community members. These channels included public *barazas*, infographics, student career pathing opportunities, stakeholders' meetings, domestic animal treatment forums (including vaccination drives), and ecosystem restoration initiatives. Various public and private stakeholders contribute to this, including the national and county governments.

Results

Through training in ecosystem restoration and conservation, multiple woodlots have been established to protect biodiversity in the region and also provide forage for bees and other pollinators. Many women and youth from the surrounding community have subsequently been educated and empowered in apiculture. Through environmental

National Museums of Kenya and Nature Kenya Staff offering experiential learning on ornithology.

Figure 6. Land Cover Classes of the Maasai Mara National Reserve. (Source: Spagnuolo et al 2020).



clubs (Maasai Mara Environment and Wildlife Club and the Tourism Association of Maasai Mara University), over 150 students and staff are actively engaged in tree planting and habitat restoration within these woodlots, which contribute to climate change adaptation and mitigation. These activities have also contributed to water tower conservation, transboundary water resource management, and lessened the pressures emanating from forest degradation and destruction.

Furthermore, there has been increased uptake of behaviour change in how both students and community members involved in the projects handle their household and e-waste. Through education initiatives, waste segregation bins and collection points have been established throughout the region. Community members are also more aware of energy consumption, manifested in them turning off light bulbs and using more ambient light. Maasai Mara University, a member of RCE South Rift, has also taken a proactive approach to establish green spaces and waste water treatment. By installing oxidation ponds, effluence from student hostel facilities is treated before it is used to water trees and lawns. The university has also harnessed kitchen waste to produce methane, a form of biogas. The effluent left from the kitchen waste is used as organic manure which contributes to food security and income diversification. These university facilities are open to interested members of the public as a living lab on sustainable waste management.

Actions to Take:

The communities the RCE worked with had many good practices at the household or neighbourhood level for a number of sustainability initiatives, especially in regards to the conservation of native plant species. However, these practices were not shared between the different community members until the RCE consolidated these good practices – to be successful, there was a need to coordinate and disseminate this information to upscale behaviour change.

Researchers being taken around a land parcel to be mapped.

Chapter Africa

Evaluation of Land Use Changes and Land Tenure Systems Using Social Tenure Domain Model (STDM) Techniques in the Taita Hills Forest Eco-Region

RCE Greater Pwani

Situation

The Taita Hills forms the most northern part of the Eastern Arc Mountains and their forests are included in one of the 36 global biodiversity hotspots (Eastern Afromontane). The indigenous mountain rainforests in the hills represent the fragmented relics of primitive and formerly widespread forest flora and fauna from 30 million years ago. During a cooler and drier period some ten million years ago, the area's lowland forest became savannah, leaving the forests surviving on the isolated peaks and ridges of the Taita Hills the only remnants of a once expansive ecosystem. The Taita Hills' forested ridges and peaks have been isolated from one another for a long time, contributing to the present high degree of endemism that includes plants, vertebrates, and invertebrate taxa. The forests in the Taita Hills are also ranked as one of the Important Bird and Biodiversity Areas (IBA) in Kenya, with a number of both endemic and rare species. Many of the species that have survived in these mountain forests are not found elsewhere in Africa today. These include the critically endangered Taita thrush (*Turdus helleri*), the endangered Sagalla caecilian (*Boulengerula niedeni*), and the near threatened Taita blade-horned chameleon (*Kinyongia boehmei*) (*EANHS 2017*).

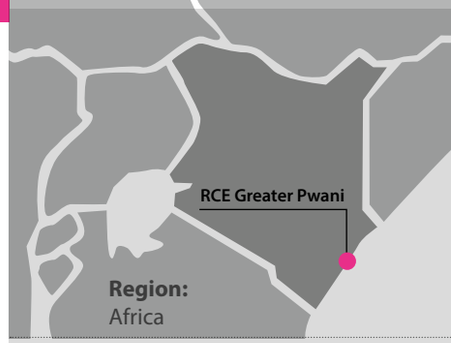
Issue/s

The forests of the Taita Hills have suffered substantial degradation due to the expansion of agricultural activities in the region (*Pellikka et al. 2013*). Scarcity of arable land has put pressure on the available natural resources in the region. Both high population pressure as well as a predominance of agriculture in economic activities has pushed human land use further up the hills and caused significant changes in land use and land cover patterns in the region (see figures 7 and 8 on pages 46 and 47). As a result, the Taita Hills cloud forest is now highly fragmented. The cause of this fragmentation and corresponding drop in biodiversity in the Taita Hills can largely be traced to the increasing number of landless people in the region moving into the Taita Hills, as they have lost their traditional farm lands due to illegal land evictions, poverty, or internal displacement (*CGTT 2018*). However, what is not clear is why there are increasing numbers of landless people settling in the Taita Hills, and what happened to make them move into the region. Land allocation is a burning social and ethical issue across much of Africa, as many governments do not have robust land tenure system for communities and privatisation pushes more and more people off of what was once community commons. Additionally, the long process of land adjudication and settlement schemes contributes to the problem, as even if displaced people may get their land back, they must live somewhere in the meantime. Because there is limited information on the specific causes of land use and land cover change in the region, RCE Greater Pwani set out to identify what was driving land use changes and land tenure security systems in communities of the Taita Hills. By understanding the impact of land tenure systems on land use changes in the Taita Hills, it was hoped stakeholders could be educated on alternatives that would protect both the forests' biodiversity as well as the communities' livelihoods and well-being.

Responses/Actions Taken

RCE Greater Pwani used questionnaires and conducted face-to-face interviews to determine the causes of land use and land cover changes in the region. The RCE also mapped land

Researcher taking a picture of a landowner for an application using the Social Tenure Domain Model (STDM) tool.



Country: Kenya

SDG(s): No Poverty, Zero Hunger, Quality Education, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life on Land

Theme(s): Agriculture, Arts, Disaster Risk Reduction, Forests/Trees, Plants & Animals, Traditional Knowledge

Target audience(s): Community

Ecosystem(s): Agricultural, Forest, Freshwater, Grassland, Urban/Peri-Urban, Wetlands

GAP Priority Action Area(s) (or ESD for 2030 Priority Action Areas): 1, 5

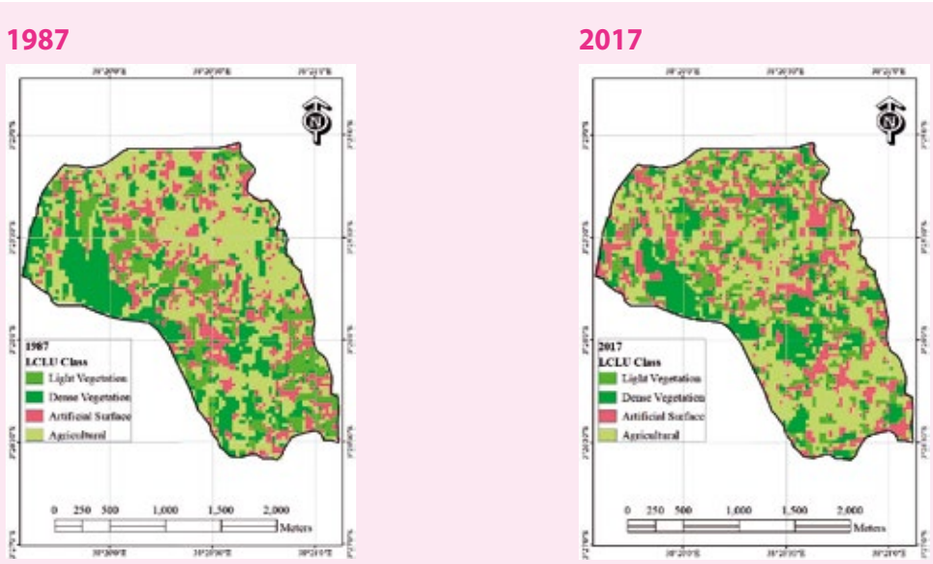
Language(s) of project: English

Contributing organisation(s):
- Pwani University
- Taita Taveta University
- South Eastern Kenya University
- Technical University of Munich

Linkages to education and/or sustainable development policies:
- National Land Policy, Sessional Paper No. 3 of 2009
- The Physical and Land Use Planning Act, CAP 286, of 1996-2019
- The Land Act, No. 6 of 2012
- Gender Policy of 2011

Duration of project: May 2018 – ongoing

Figure 7. Land Cover & Land Use Status Maps results for 1987 and 2017 in Taita Hills. (photo: Hamisi Tsama Mkuzi).



parcels to quantify what type of land use and land cover changes the region was experiencing, using a geographic software, ArcGIS, to analyse a series of satellite images over time to observe the changes. Socio-economic data from the surveys were integrated into the maps generated by satellite imagery to integrate data on the human population with observed land use and land cover change. The data generated was intended to educate policy makers and other stakeholders about why people were moving to the Taita Hills, and with this information, generate data-informed solutions that would protect the forest and the surrounding communities. This project made an intentional effort to provide equal opportunities to both men and women among the community members interviewed as well as the research team. Because approximately 73% of women within Taita Taveta County do not own land, and because most land ownership decisions are made by men (*Mwakumanya et al. 2016*), it was critical to gain women's insights and understand their experiences in regards to land use within the region.

Results

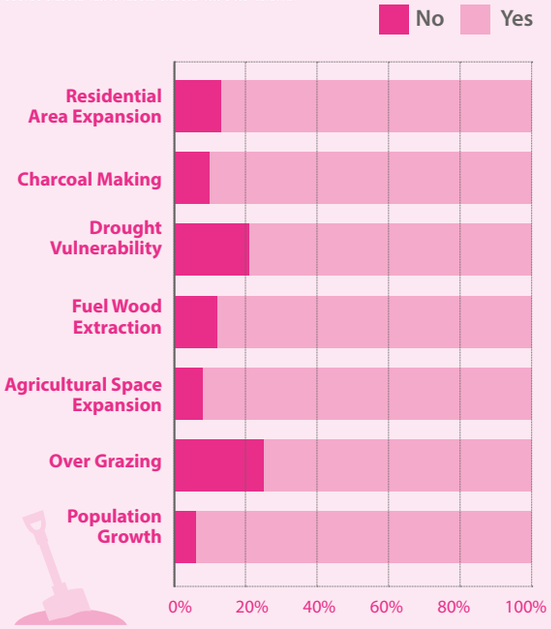
The majority of households interviewed reported that the processing of deeds or other ownership documents for land acquisition was exceedingly difficult and cumbersome with the current bureaucratic process, hence they resorted to using forest land to meet their livelihood needs. Unclear land regimes coupled with a difficult and time-consuming bureaucratic process for transferring or subdividing land – even within a family – has created a land tenure system that is difficult, if not impossible, to use. Growing populations, expanding agricultural land, charcoal making, and fuelwood extraction were reported as specific leading causes of deforestation among households interviewed. However, the expansion of residential areas, over-grazing, and drought were also cited as reasons for deforestation within the region. These findings on the causes of so many landless people, in particular women and marginalised communities, and the subsequent numerous causes of deforestation in the region were presented in meeting briefs to local administration leaders. This awareness of and education on this complex problem is the necessary first step for policy makers to begin addressing the issue through concrete actions.

Figure 8. Land Use and Land Cover Changes and Drivers. (Source: Mkuzi 2020).

1. Land Use (LU) & Land Cover (LC) Change Drivers

(as perceived by households (%) in Taita Hills, Taita Taveta County) (n=141)

To understand the underlying drivers of land use and land cover changes, socio-economic data from field survey were integrated with land use and land cover data.

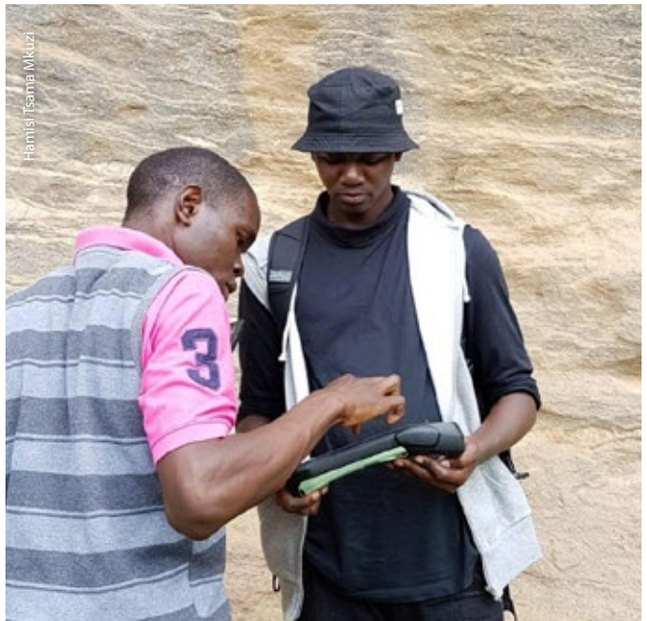


2. Land Use and Land Cover (LU & LC) Change (km²) in Ngerenyi Area between 1987 and 2017

Natural habitats, mainly dense vegetation decreased throughout the years in favour of built-up surfaces by 17.1%.

Land Cover Type	Overall Change (1987–2017)	
	Area (km²)	%
Agricultural	-4	-2.1
Built-up Surfaces	17	18.5
Dense Vegetation	-20	-17.1
Light Vegetation	7	11.5

Researchers from Pwani University and Technical University of Munich navigating around land tenure mapping tools.



More Information:

Reconciling Human Livelihood Needs and Nature Conservation (DAAD-Quality Network Biodiversity Kenya - 2016–2019)

Actions to Take:

When working with research in any community, it is critical to explain the purpose of the research before asking questions to ensure respondents understand the research being done. This helps give those interviewed a sense of ownership in the knowledge generated, and helps to weed out irrelevant responses. Consent must be given before any person is interviewed or any information is collected from them.

Mariusz Slonski | unsplash.jpg

Chapter Europe

Region:
Europe

Country:
Poland

SDG(s):
Good Health and Well-Being, Quality Education, Gender Equality, Sustainable Cities and Communities, Climate Action, Life on Land

Theme(s):
Arts, Curriculum Development, Ecotourism, Forests/Trees, Plants & Animals

Target audience(s):
Primary, Secondary, Higher Education, Teacher Education, TVET, Community, Youth (Informal)

Ecosystem(s):
Forest, Fresh Water, Urban/Peri-Urban, Wetlands

GAP / ESD for 2030 Priority Action Areas: 2, 3, 5

Language(s) of project:
Polish

Contributing organisation(s):
- University of Warsaw
- Kampinoski National Park
- Warsaw Municipal Authorities
- Maria Grzegorzewska Pedagogical University
- Cardinal Stefan Wyszynski University in Warsaw
- The Earth and People Foundation

Linkages to education and/or sustainable development policies:
- Convention on Biodiversity – Article 13 – international
- National Strategy of Environmental Education – Through Education to Sustainability - national

Duration of project:
September 2017 – ongoing

A Place for Cooperation between an Urban Zone and a National Park – Interrelatedness of Environmental and Social Issues in Warsaw

RCE Warsaw Metropolitan

Situation

The City of Warsaw is home to 1.75 million people. It is surrounded on all sides by a more or less contiguous green belt of temperate mixed coniferous and deciduous forest which is what remains of Mazovia province's once-extensive primaeval forest (Puszcza). The remnants of this primaeval forest constitute the Kampinos Forest Biosphere Reserve (KFBR), which is on the list of UNESCO Biosphere Reserves. The best preserved part which is also the richest in biodiversity, is protected as the Kampinos National Park (KPN) to the north-west of Warsaw. The KPN is also on the list of UNESCO Biosphere Reserves. The park is habitat for many of Poland's iconic animal species, including moose (*Alces alces*), Eurasian lynx (*Lynx lynx*), and Eurasian cranes (*Grus grus*) (see figure 9 on page 53).

Education for family groups, seen observing bats. A park ranger guiding observation of bats' hiding places during a workshop on bats 'cohabiting' with people in human settlements.

M. Szajnowski, Kampinos National Park


M. Szajnowski, Kampinos National Park

Out of class learning – school children learn to recognise fungi.

Issue/s

The KPN and other protected areas close to or even inside Warsaw's metropolitan agglomeration are very important resources for critical ecosystem services, environmental education, and recreation for urban citizens. However, the awareness of how critical these natural habitats are and what actions can be done to protect them is not sufficient among the neighbouring urban population. The directors and staff of the KPN are looking for education initiatives on biodiversity that not only attract more visitors to the park's educational trails, but at the same time use education to change citizens' behaviours which have a negative effect on the park's and other protected areas' ecosystems. For example, straying from delineated routes creates additional foot traffic that causes the destruction of plants and fungi within the park, which contributes to soil erosion. The careless disposal of garbage in and around the park can damage the region's soil and water quality (as well as the park's wildlife). Furthermore, careless use of fire can put the park and the surrounding urban area at risk for out-of-control wildfires.

The KPN strives to raise awareness about the positive impact of the park's ecosystems on the city and its residents, such as improving air quality and allowing for healthier residents through the use of the park for recreation purposes. Key to the preservation of the biodiversity that renders these services is restriction of anthropogenic pressures inside the park. In addition, cooperation and communication with the local community is important in developing a positive attitude about the park and other protected areas for the city's urban residents and to promoting daily practices that put residents into contact with the natural world without harming it. Therefore, it is necessary for visitors to KPN to realise that it is possible to both enjoy and preserve the area in good condition if it is used responsibly.

Responses/Actions Taken

The goal of this RCE project was to popularise national parks as very important institutions playing a critical role in adaptation to climate change, serving better health conditions for the community, and providing recreation and relaxation experiences for everybody. Through individually tailored methods of communication and information sharing utilising both formal and non-formal education, the project was designed to inspire behaviour changes for a more healthy and sustainable way of living in the region's urban zones, using educational opportunities created by urban protected areas, especially Kampinos National Park. The municipal authority worked with non-formal education and provided sufficient bus transportation from the city to the park's gates, enabling better and more equitable access to the education programmes in the

Park visitors on the educational trail in the Kampinos National Park.

park to a wider audience. Maria Grzegorzewska Pedagogical University worked through formal education and training to prepare primary and secondary teachers to be ready for out-of-class environmental education in KPN, while Cardinal Stefan Wyszynski University organised regular training for university students. Meanwhile, the University of Warsaw organised a special exhibition

University students on a field study in the Kampinos National Park.

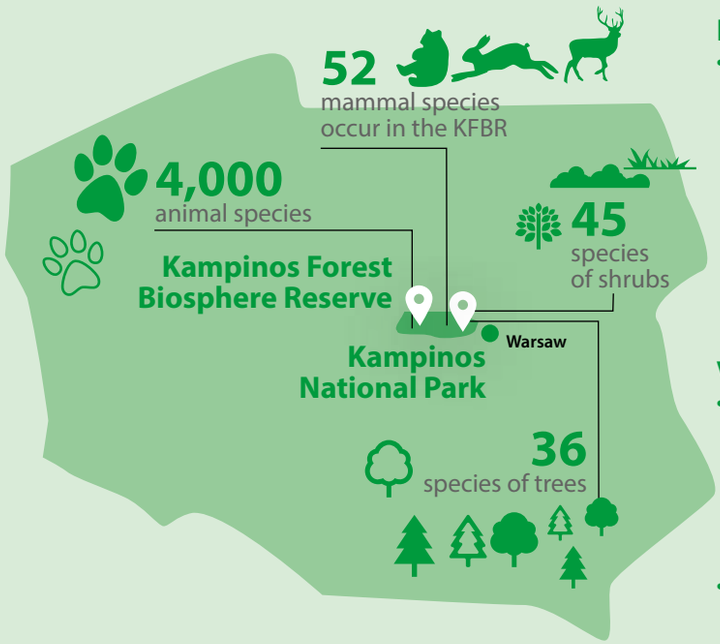
on the role of the forest in the adaptation of the urban zone to climate change for the larger metro community. KPN itself continued and expanded its non-formal education initiatives for park visitors.

Results

The meetings and consolidation of RCE Partners has been a good result in and of itself. This has allowed for an exchange of experiences in methods for education on biodiversity between KPN and other partners. As a result of this project, it is now possible to exchange knowledge and experience between all of the partners working on local biodiversity education more efficiently and for greater impact.

The role of social participation in the area's ecosystem management is also growing. The KPN has many contacts with residents and social organisations operating in the park itself and its surroundings. There has been an increase in social activity and citizens' initiatives aimed at environmental conservation as a result of their

Figure 9. Fauna and Vegetation in the Kampinos Forest Biosphere Reserve. (Source: Owadowska et.al 2013; Andrzejewska A et.al 2020).



Fauna

- About 4,000 animal species identified in the Kampinos Forest Biosphere Reserve (KFBR) (estimated 16,000 species occur in the KFBR, representing 50% of Polish fauna)
  - About 3,000 species of invertebrates identified in the KFBR
  - 52 mammal species occur in the KFBR

Vegetation

- Main species in the KFBR:
  - Scots pine *(Pinus sylvestris)*
  - Pedunculate oak *(Quercus robur)*
  - Black alder *(Alnus glutinosa)*
  - Silver birch *(Betula pendula)*
  - White birch *(Betula pubescens)*
- In addition:
  - 36 species of trees
  - 45 species of shrubs

increased knowledge of and exposure to the park and its education programmes. Furthermore, the role of social media in education and volunteering for biodiversity conservation is growing within the region.

A.Kalinowska

Intergenerational handbook on biodiversity for seniors and grandchildren, 'Biodiversity it is also Us' by A. Kalinowska & A. Batorczak.

After publication of a resource hand-book *Biodiversity it is also Us*, the same approach has been used at other protected areas within Poland in a separate project (carried out by The Earth and People Foundation) entitled *Green Knowledge for the Universities of The Third Age* oriented at inter-generational education of seniors and their grandchildren.

Actions to Take:

The diversity of partners in an RCE project is an important opportunity for activation of different social groups towards the same goal when looking at protecting biodiversity in a region. Also, a key message to communicate to the communities in an education project such as this, comes from the slogan from one of the streams at the IUCN World Parks Congress 2014: *'Healthy Parks Healthy People'.*

SDGs in Espoo's School Culture: Our Schoolyard as an Ecological Learning Environment

RCE Helsinki Metropolitan

Situation

The Helsinki Metropolitan area is located in the south of Finland on the Baltic Sea near the juncture where the mixed forests of the south-west meet the taiga forests of the north. The region has a humid continental climate due to its proximity to the Baltic Sea and the North Atlantic Current, meaning Winter temperatures are milder than in the north of the country. The metropolitan area has very good air quality and is characterised by high levels of socio-economic development, with equitable access to good healthcare and education for the urban population.

Issue/s

The region has made steady progress on socio-economic indicators of development within the Sustainable Development Goals (SDGs), with low poverty rates (Goal 1), access to good healthcare systems (Goal 3), and reducing inequalities among its population (Goal 10). However, like many highly developed regions around the world, Helsinki Metropolitan struggles with environmental sustainability, including responsible consumption and production (Goal 12), taking action to address climate change (Goal 13), and protecting the region's terrestrial biodiversity (Goal 15). The regional forests' biodiversity is under threat from climate change, land use change, over-consumption of natural resources, pollution, and invasive species (see figure 10 on page 57).

Children enjoying a forest trip at Nuuksio National Park in Espoo, Finland.

The secret of biodiversity is revealed (also) through species books.

Responses/Actions Taken

RCE Helsinki Metropolitan wanted to build a common understanding of the threats to biodiversity among the communities within the region and raise awareness of what actions learners could take to conserve the forests and their many different species. Since the Finnish National Core Curriculum guidelines specify the need for promoting sustainable ways of living among learners, working within a school setting gave the RCE an entry point of where to start. The RCE worked with Keinumäki School on a pilot project to bring natural environments into the schoolyard to transform the learning environment and also allow teachers, students, and their families to develop a relationship with nature. The RCE partners worked to create curriculum and train teachers on how the school gardens and nearby forest could be used as learning spaces not only for biology and ecology, but for other subjects such as geography, mathematics, music, art, and physical education. By embedding these subjects in the schoolyard rather than the classroom, the biodiversity of the region became embedded in the curriculum instead of becoming an add on. When certain aspects of nature could not be brought into the schoolyard, the schoolyard went to them by taking students and teachers on field trips to other nearby lakes and forests through the Finnish Kids Forest Trip programme.

Country: Finland

SDG(s): Good Health and Well-Being, Quality Education, Industry, Innovation and Infrastructure, Sustainable Cities and Communities, Climate Action, Life on Land

Theme(s): Traditional Knowledge, Agriculture, Arts, Curriculum Development, Forests/Trees, Plants & Animals, Waste

Target audience(s): Primary, Teacher Education, Community

Ecosystem(s): Urban/Peri-Urban

GAP / ESD for 2030 Priority Action Areas: 1, 2, 3, 4, 5

Language(s) of project: Finnish

Contributing organisation(s):
- Keinumäki School, City of Espoo
- Aalto University
- University of Helsinki
- Association for Science Education

Linkages to education and/or sustainable development policies:
- Finnish National Board of Education – National Curriculum Implementation Policy

Duration of project: August 2018 – ongoing


Suomen lasten metsäretkipäivä

Lakes and forests are close to all Finns.

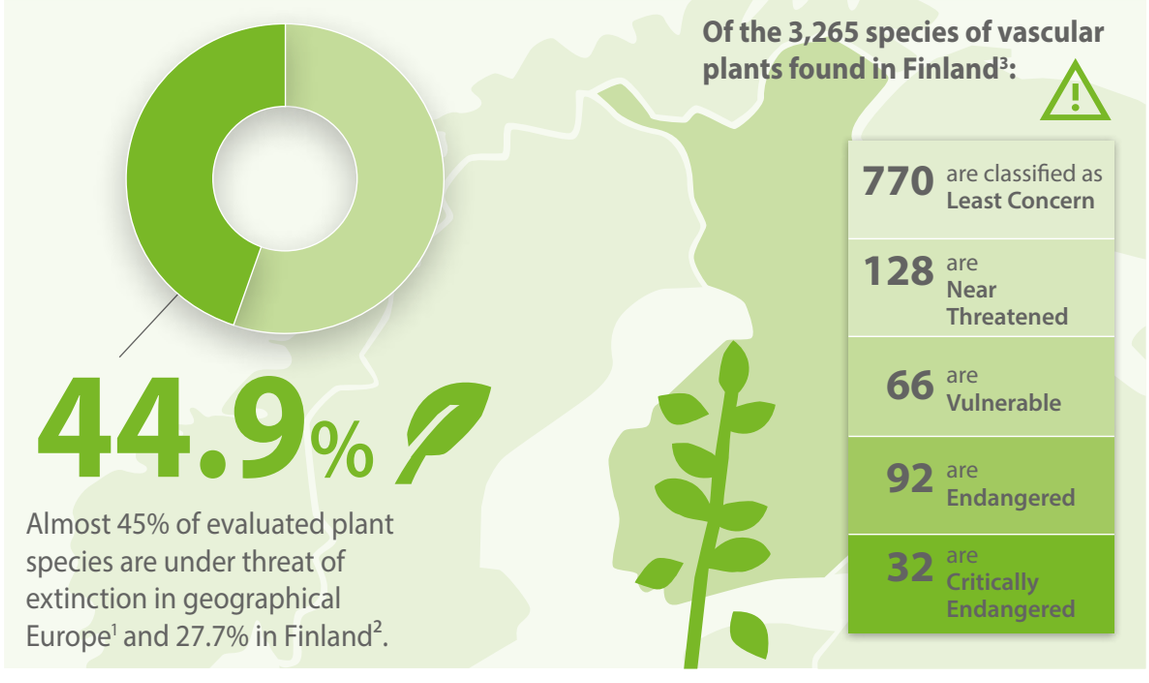
Results

Since the implementation of the project, Keinumäki School has received annual awards and recognition from LUMA – the science education network of Finland's universities. Because of this recognition, information about the project's curriculum and pedagogy has been disseminated to kindergartens and primary schools throughout the country for replication in their own schoolyards. In addition, based on experiences with the project, partners from RCE Helsinki Metropolitan have gone on to train kindergarten and primary school teachers around Finland in science, sustainable development, and ESD issues within the context of regional biodiversity and culture. The Finnish Kids Forest Trip continues to reach thousands of educators and their students, with at least 20,000 participants in the programme yearly. Outdoor classes also helped in generating baseline data for conservation measures as approximately 28% of all plant species identified by students during the first year of the programme are listed as threatened species within Finland (*Bilz et al. 2011*).

A school garden expert talks about gardening and harvesting season measures in the schoolyard.


Keinumäki school

Figure 10. Plant species in Finland are under threat.
(Sources: [1] Bilz et. al 2011; [2] Rassi et. al 2010; [3] Finnish Biodiversity Information Facility).



All kinds of movement, play, and adventure promote children's connection to nature.


Suomen lasten metsäretkipäivä

More Information:

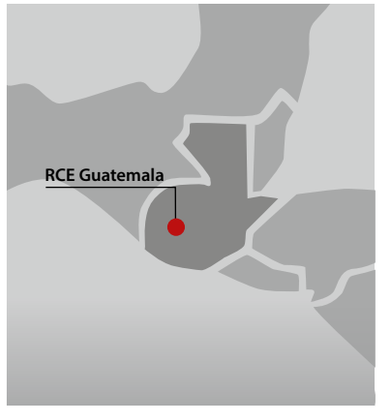
- Science School Model in Keinumäki school
- LUMA Center Finland
- Finnish Kids Forest Trip Day

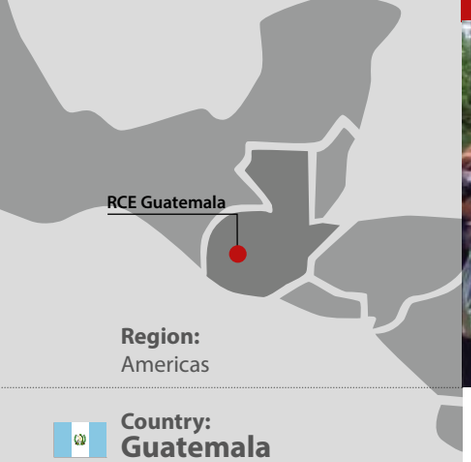
Actions to Take:

The process of developing a schoolyard into a learning space should take a participatory design approach, including school staff, teachers, administrators, students, parents, and people living in the surrounding neighbourhood. Using a participatory approach creates a sense of motivation as well as a sense of ownership in caring for the environment. Both transformability and multifunctionality should be considered in any schoolyard design. Natural environments tend to promote both wonder and physical movement – two things lacking in most school systems no matter how high their PISA (Programme for International Student Assessment) scores!

Hamilton Greenwood

Chapter Americas





Region:
Americas

Country:
Guatemala

SDG(s):
Quality Education, Clean Water and Sanitation, Climate Action, Life on Land

Theme(s):
Curriculum Development, Ecotourism, Forests/Trees, Plants & Animals, Traditional Knowledge, Waste

Target audience(s):
Higher Education, Teacher Education

Ecosystem(s):
Forest, Fresh Water, Mountains, Wetlands

GAP / ESD for 2030 Priority Action Areas: 2, 3, 5

Language(s) of project:
Spanish

Contributing organisation(s):
- Maya K'iché Community
- Maya Lacandón Community
- Maya Mopán Community
- Maya Q'eqchi Community
- Universidad de San Carlos de Guatemala

Linkages to education and/or sustainable development policies:
- University Strategic Plan 2002 – 2022 - national

Duration of project:
August 2017 – ongoing

University professors with Indigenous Maya Kiches at the top of the communal forests of Totonicapán, prior to a study trip to learn how they apply their ancestral knowledge in the preservation of forests, watersheds and tributaries of the main rivers of the country.

Chapter Americas

Learning to Love our Bio-Cultural Diversity through our Rivers

RCE Guatemala

Situation

Guatemala is a country with a great degree of geographic and climatic variation, ranging from hot and humid tropical lowlands to cooler and more temperate mountain highlands. The country is home to numerous rivers, including the Usumacinta, San Simón, and Candelaria Rivers. Those that flow into the Gulf of Mexico are the largest, such as the Usumacinta. The longest network of subterranean rivers in Central America is also found here. The main river of this underground network is the San Simón, which receives several tributaries, such as the Candelaria River. This network of rivers disappears and reappears several times under limestone hills, forming the Candelaria Caves, which are considered sacred to the Mayan civilisation. These rivers are vital freshwater sources both for numerous communities around the country, but also for native terrestrial and freshwater biodiversity within the country. The Usumacinta River is surrounded by a tropical forest with a wide range of trees such as ceiba (*Ceiba pentandra*), mahogany (*Swietenia macrophylla*), and palo blanco (*Tabebuia donnell-smithii*). These forested riverbanks provide habitats for many species of storks, herons, parrots, pelicans, turtles, lizards, and troops of howler monkeys (*Alouatta pigra*). Under the water's surface are many species of freshwater fish, such as snook (*Centropomidae spp.*). The Usumacinta River flows for several kilometres along the border line that separates Guatemala from Mexico. Archaeological sites of the Mayan civilisation and national parks for the protection of the Mayan biosphere shared by both countries are located at various points along the banks of both sides of the river. In recent years the resident Indigenous communities have organised themselves into associations and cooperatives for the conservation of these cultural and natural heritages. They manage access to the parks and archaeological sites and offer talks on the natural and cultural history, including the fauna and flora of each site. They also offer visitors several of their own resources for transportation, lodging and food, within a low-impact rural tourism scheme. A similar experience is offered when visiting Guatemala's network of subterranean rivers that form the Candelaria Caves.

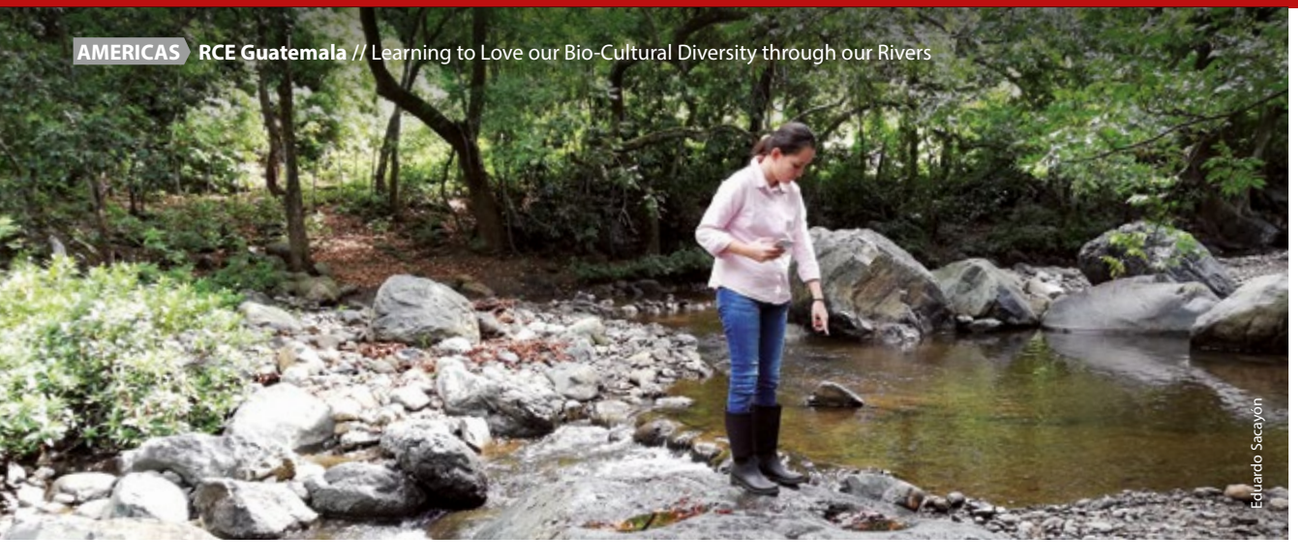
The Dulce River flows into the Atlantic Ocean, and is a source of work for small businesses run by Indigenous communities dedicated to tourism in the Caribbean region.

Issue/s

Guatemala is considered to be a country that has a great wealth of water resources, using only 10% of full capacity. However, a big problem within the country is the use and inequitable distribution of this resource. 38% is used by industry, 32% by the agricultural sector, 25% for the production of hydroelectric power, and only 2% for households, as seen in figure 11 on page 63. In addition, 50% of the total population has no water services in their home. For the other 50% of the total population, 60% of these households do not apply any treatment to the water used for drinking (*MARN 2017*). Additionally, most communities living in the territories possessing the greater abundance of water resources, are characterised by the highest rates of poverty and low levels of human development. In many cases, private businesses are granted access to the usage of rivers, resulting in social unrest as well as the displacement of thousands of people due to hydroelectric installations. Subsequent poor management of the river basins housing these projects has resulted in pollution of surface and groundwater, reduced water flow, erosion and degradation of soil, loss of forest cover and associated habitat, as well as flooding, droughts, and landslides.

A tourist guide from the Queqchi Mayan Indigenous Association, prior to a study trip through the subway river system and lagoons of the Candelaria caves.

In Guatemala, education for sustainability and the environment was established in the Public Educational Project or Core National Curriculum for children in primary and secondary education, after the signing of the Peace accords in 1996. However, very little of these educational plans have



A woman who owns a small hotel, high in the Sierra de la Minas watershed, shows the quality of the water in one of the small streams that are tributaries of the Motagua River.

been implemented, and ESD in higher education is not accounted for. In particular, the study and teaching of rivers in higher education is very biased towards disciplines such as biology and agronomy, resulting in a study of the rivers that is descriptive, fragmented, and out of the historical, socio-economic, cultural, and political context. As a result, there is a lack of didactics and methodologies to understand the meaning of natural heritage, landscape conservation, aesthetic appreciation, and active participation for the integral management of water ecosystems among those with university education within the country.

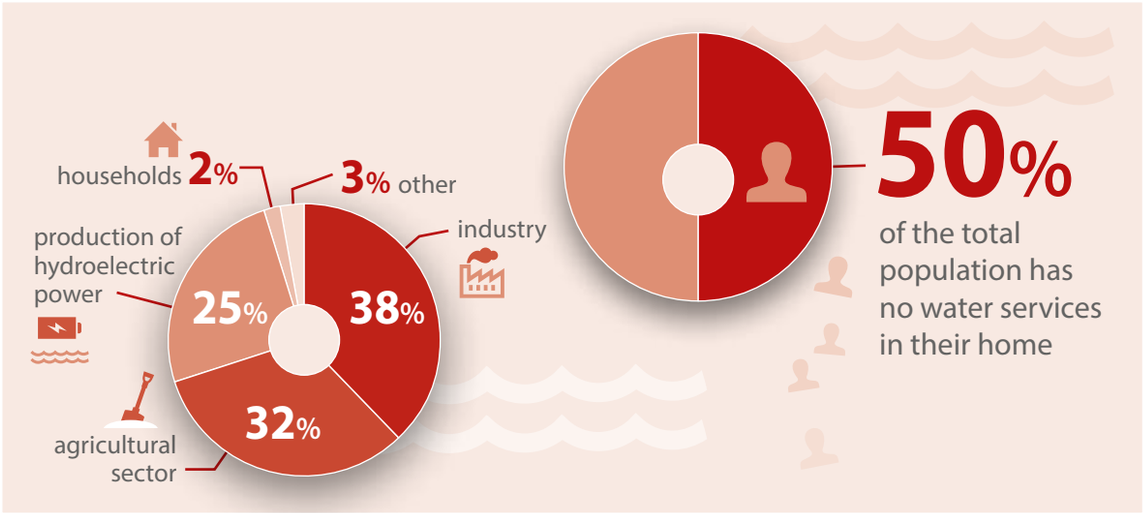
Responses/Actions Taken

The foundation for this RCE project was to provide new approaches to teaching bio-cultural diversity with critical thinking to promote social participation in valuing, protecting, and conserving the ecosystems around rivers as part of the national heritage. The idea was to train university professors using teaching strategies that allow them to engage with experiential learning generally associated with the knowledge of Indigenous peoples in the region. To study the close relationship between forests, rivers, and communities, the team visited one of the community forests that is managed by associations of Indigenous Maya Kiches, in the department of Totonicapán. The Maya community shared their ancestral knowledge with the teachers on how to conserve a large and high watershed of several rivers within the country. The methodology for this project required the teachers in training to perform theoretical and applied activities before, during, and after the educational trips to the rivers to understand water as a fundamental condition for life.

Prior to the field trips, participants are required to study recommended bibliographic, audio-visual, and podcast sources. The purpose is to understand the value of rivers and their relationship with the biological and cultural diversity of their environment. On site, participants were taught about the historical association between society and rivers, including their strategic, commercial and religious importance. Upon returning to their classrooms, the professors were to demonstrate a connection between their previous descriptive

Indigenous women who make handicrafts from local raw materials offer their products to tourists and other visitors to the Dulce River.

Figure 11. Water Resource Distribution Usage in Guatemala.
(Sources: Ministerio de Ambiente y Recursos Naturales (MARN) & Agencia de Cooperación Internacional del Japón (JICA) 2017. p23. [left]; Ministerio de Ambiente y Recursos Naturales (MARN) 2017 [right]).



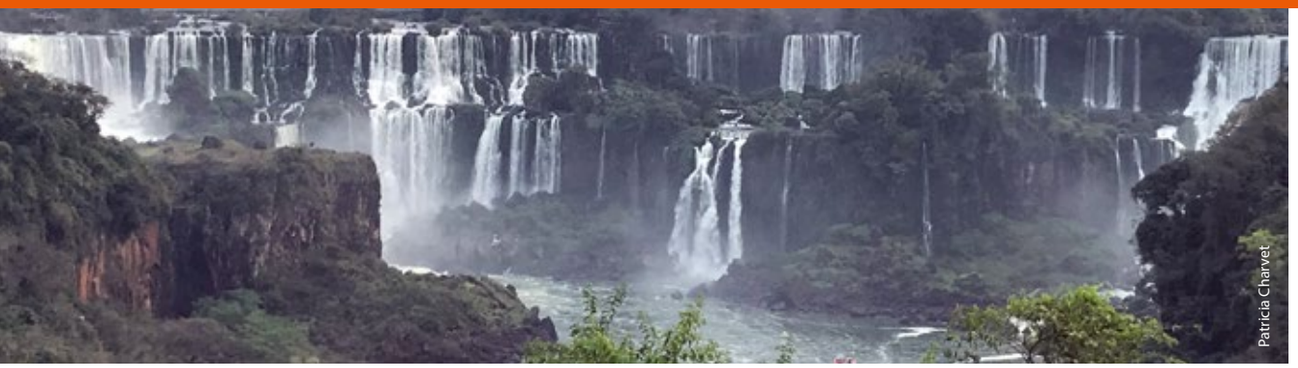
theoretical knowledge and their new applied knowledge within their pedagogy. In other words, a model of heritage pedagogy was applied. Particular attention was paid to understanding the integrated management of water resources to assure availability and sustainable use for both people and biodiversity in the region.

Results

Although the course is aimed at university professors, the project is expected to also provide a similar course for primary and secondary school teachers in the future. The university professors who have participated have motivated other professors and students from their academic units. In this way, little by little, other professors and students have incorporated aspects of applied learning into their own teaching. The course was also replicated in other university centres in provinces throughout Guatemala. The most common expression of university professors is their satisfaction with the results of the project. They say that now they are more interested in learning about other sites and places related to the history of the Mayan culture and other natural heritages associated with the country's rivers and forests. With this knowledge, universities can teach their students more holistic ways to understand and protect the nation's bio-cultural diversity along its many rivers.

Actions to Take:

The organisation of study tours requires planning where the objectives, strategies and pedagogical results of the projects are clearly defined. An Important aspect is to define a work plan together with the community organisations and Indigenous associations regarding logistics and schedules for the participants. Study tours require a scheme of rules and guidelines, which must be known and accepted by all members of the course. Under this scheme each person must strictly comply with the established schedules, including knowing when activities begin, correct meeting places, and amount of time spent at the sites. Proper respect needs to be conveyed in the places visited, many of which are sacred. Due caution must be exercised in all field activities, so as not to put the life of any participant at risk.



The Iguaçu Falls, a UNESCO World Heritage Site and part of the Paraná River Basin.

Chapter Americas

Danger Under the Surface? Managing Human-Wildlife Conflict with Freshwater Chondrichthyan Species in the Paraná Region

RCE Curitiba-Paraná

Situation

Paraná is a State of Brazil, located in the south region of the country and named for the Paraná River that runs through the region on its journey to the Atlantic Ocean. The Paraná River Basin is one of the main drainages in South America and one of its most famous tributaries is the Iguaçu River, internationally known for its amazing waterfalls, a UNESCO World Heritage Site. This basin is located in a transition region with a tropical to subtropical climate and possesses a very high level of biodiversity, including aquatic species that are found in various freshwater ecosystems, such as streams, rivers, lakes, wetland areas, and waterfalls. Despite all of the parks and protected areas established in this region, many freshwater ecosystems are still heavily impacted by agribusiness, industrial, and urban development in the southern region of Brazil and neighbouring countries. In addition, parts of this basin have been used to establish hydroelectric power plants; therefore, reservoirs and dams have already altered the original drainage of rivers in this Basin (*Agostinho et al. 2007*). The Itaipu Binacional, located in the Paraná River, is the second largest hydroelectric power plant in the world, after the Three Gorges Dam in the Yangtze River, in China. Its building involved the flooding of the Sete Quedas Waterfalls, altering the distribution of fish species that previously had these waterfalls as a natural barrier (see figure 12 on page 67).

Among the fish species that increased their range of distribution with the damming, there are species of Neotropical freshwater stingrays (genus *Potamotrygon*, subfamily Potamotrygoninae). These stingrays, which have their reproductive cycle linked to rivers' hydrological cycles, started invading areas where previously they were not present (*Garrone-Neto et al. 2014*). The problem with this is that these fish can inflict very painful and serious wounds when stepped on as a direct defense mechanism. Fishers and riparian people in the region have always feared or hated them, despite their little-known key role as an aquatic food chain predator and contributing to the balance of the surrounding ecosystem. This project interacts mainly with low-income riparian and fishers' communities in one of the main river basins of South America. Accidents with freshwater stingrays are a now a problem and part of the daily routine for many of these communities, but can be simply avoided by educating on easy-to-follow recommendations when carrying out activities in or by the rivers.

Issue/s

People and freshwater stingrays have co-existed for a long time. However, many of those communities are in very remote areas where access to basic formal education is still a challenge. Some people in the region view rivers as an infinite natural resource, but challenges related to habitat loss and degradation have increased significantly in the past several decades and this is not understood. Some communities do not see freshwater stingrays as part of their local or national fish fauna, while others capture them for the ornamental fish trade. All community members that approach the water in the region can potentially have accidents with these rays which have powerful necrotic venom on their stinging tails. In some cases, wounds from stings lead to temporarily and even permanent disabilities. However, these accidents can be easily avoided and have a reduced impact through education about the rays, as well as education on simple first aid care to be given to any person who is stung right away. Both the residents of riverine areas and fishers dislike freshwater stingrays mainly due to the sting wounds that they inflict. However, these communities and the rays are both subject to river systems degradation and human impacts, and thus communities must learn to safely co-exist with the rays as they are a crucial part of the rivers' ecosystems and their habitat has been altered and degraded.

The dam of the Itaipu Binacional Power Plant in the Paraná River.

Country: Brazil

SDG(s): Good Health and Well-Being, Quality Education, Clean Water and Sanitation, Life Below Water, Life on Land

Theme(s): Ecotourism, Plants & Animals, Traditional Knowledge

Target audience(s): Community

Ecosystem(s): Fresh Water, Wetlands

GAP / ESD for 2030 Priority Action Areas: 2, 4, 5

Language(s) of project: Portuguese

Contributing organisation(s):
- Universidade Federal do Paraná (Federal University of Paraná - UFPR), Programa de Pós-Graduação em Sistemática, Uso e Conservação da Biodiversidade da Universidade Federal do Ceará (Graduate Program in Systematics, Use and Conservation of Biodiversity of the Federal University of Ceará - PPGSIS - UFC)
- Projeto Trygon (Trygon Project)
- Grupo de Estudos de Elasmobrânquios do Paraná (Elasmobranch Study Group of Paraná - GEEP)
- Regional fishers associations

Linkages to education and/or sustainable development policies:
- Freshwater Chondrichthyan Biodiversity - IUCN SSC Shark Specialist Group – international
- Health Care System – Ministério da Saúde (Health Ministry) – national

Duration of project: January 2020 – ongoing

Responses/Actions Taken

The main objectives of this RCE project were to understand better the diversity of these species, the threats that they are subject to in freshwater environments, update an extinction risk assessment, and reduce sting accidents with fishers and riparian communities through education on simple measures that can be performed on-site at low cost. The idea was to provide information in a way that will help demystify these rays and also provide clear and simple procedures to be taken when accidents happen and to avoid accidents all together. All communication strategies were oriented to be inclusive and refer to these professionals as fishers (not fishermen, a popular term that excludes the participation of women in fisheries). Riparian men and women were both addressed when talking about the stingrays and accidents, taking into account some of the roles in some communities are segregated between sexes (i.e., women usually dedicate more time to washing objects by the rivers and therefore could be more exposed to accidents). Therefore, project communication was neutral and oriented to gender equality – for example, in training sessions, the phrase "if you are on the shore washing something or bathing, shuffle your feet to avoid stingray accidents," was contextualised for river front activities that were predominantly carried out by women, men, or mixed.

One of the challenges with this education initiative is that there are traditional practices in some regions that contaminate or worsen wounds to the point that amputations or tissue implants end up being needed. The main activities involved educating riparian fisher communities on the fact that freshwater stingrays are a unique part of our neotropical biodiversity, as well as strategies to safely co-exist with them. Formal and non-formal lectures and talks were given on measures to minimise accidents and appropriate treatment for wounds before the COVID-19 pandemic interrupted the activities (in order to avoid people gathering and travelling). Occasionally fishers would bring a dead freshwater stingray (*Potamotrygon* spp.) and asked to have an explanation and see in-person how cartilaginous freshwater stingrays differed from bony fish, mainly in terms of morphology. This project avoided producing printed material to be distributed due to sustainability issues, but, in the future, a digital (PDF) material will be produced to be used in schools and for public awareness campaigns in the communities where internet access and computers are available.

Results

The results obtained from the research conducted in this project indicate that freshwater stingrays invoved in accidents in the Paraná River basin are part of the endemic South American biodiversity. They have an important role in freshwater ecosystems, are restricted to these river basins, and subject to impacts from human activity. They are present in threatened environments, and thus subject to impacts from mining, pesticides, other sources of pollution, and riverbanks development. New extinction risk assessments are therefore being prepared.

The tail of a freshwater stingray with the feared sting; in this case two stings, since they are shed every 3-4 months, with the new one often becoming functional to ensure a defence reaction before the older one falls off.

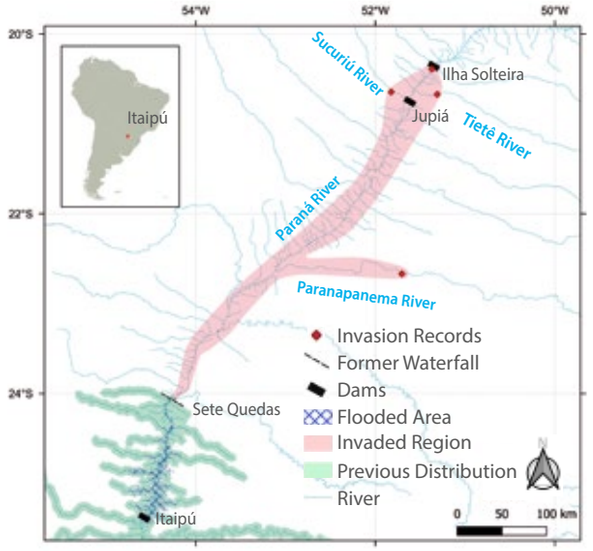
Sting wound of a freshwater stingray on a fisher's foot showing signs of local necrosis from substances found in the venomous epithelial cells that cover the sting.

Field work demonstrating to fishers how freshwater stingrays differ from bony fishes, and explaining their importance in aquatic ecosystems.

The main lessons taught were to understand and respect nature and that with due caution a pacific coexistence with less accidents could be achieved. Fishers began to understand the role that stingrays have on the aquatic ecosystem and that sting accidents corresponded to a defence (not 'attack' as initially thought) mechanism mainly when stingrays were unnoticedly stepped on or during activities at fisheries. The communities' behaviour change will likely take time, but a crucial beginning is for them to understand how to co-exist with these stingrays by minimising accidents. The number of reported human-stingray encounters have tended to drop in communities after the training.

In the Upper Paraná River Basin, it is important for the community to understand that freshwater stingrays are a new biodiversity component that they will interact with and they need to be careful around. It was critical to convey to the fishers and riparian residents that this stingray 'invasion' (amplification of distribution range) has been caused by human environmental interference (removal of a previously existing natural barrier), which all residents of the region contributed to in their demand for electricity.

Figure 12. Part of the Paraná-Prata River Basin, highlighting the freshwater stingrays' previous and present distribution (before and after the construction of the Itaipu Binacional Hydroelectric Plant).
(Source: Adapted from image supplied by Yan Torres).



Actions to Take:

There is a cultural resistance that labels a native animal as an 'evil creature'. It is important to counter this narrative with awareness that frames the species as a crucial part of the ecosystem that needs to be respected to avoid injuries. For example, freshwater stingrays are an important biodiversity component of inland waters (rivers, lakes, streams, floodplains, and others). The public in general is largely unaware that potamotrygonin stingrays are predators that help keep a healthy ecosystem by contributing to the food web balance, and also help eliminate sick or dying prey they feed on.

Region:
Americas

Country:
Canada

SDG(s):
Good Health and Well-Being, Quality Education, Clean Water and Sanitation, Decent Work and Economic Growth, Life Below Water, Life on Land

Theme(s):
Curriculum Development, Forests/Trees, Plants & Animals, Waste

Target audience(s):
Community, TVET, Youth (Informal)

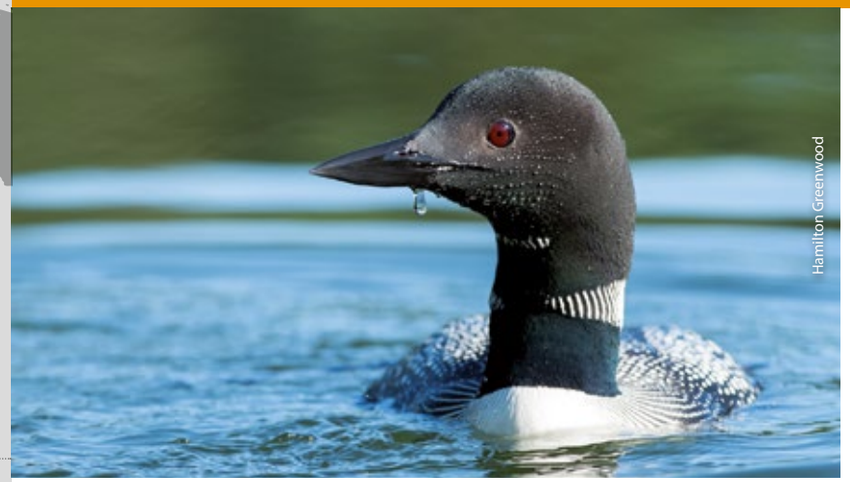
Ecosystem(s):
Forest

GAP / ESD for 2030 Priority Action Areas: 2, 3, 4, 5

Language(s) of project:
English

Contributing organisation(s):
- Saskatchewan Polytechnic
- Saskatchewan Wildlife Federation
- Prince Albert Model Forest and Saskatchewan First Nations – Stewards for the Land
- North American Wildlife Technology Association

Linkages to education and/or sustainable development policies:
- Saskatchewan Polytechnic Statement of Organizational Values: Sustainability – institutional
- Federal Sustainable Development Strategy – national


Hamilton Greenwood

The common loon: most of the species' North American population breeds in the boreal forest.

Chapter Americas

Conservation, Resource Management, and Sustainability Training at the Hannin Creek Education and Applied Research Centre (HCEARC)

RCE Saskatchewan

Situation

The Hannin Creek Education and Applied Research Centre (HCEARC) is a multi-functional facility at Candle Lake in the province of Saskatchewan. The location lies within Western Canada's boreal forest, specifically, the Mid-Boreal Upland Ecoregion identified by Acton et al. (*1998*). The ecoregion is a sub-arctic climate typified by short, cool summers and cold winters. The mean temperature of July is 16°C and mean January temperature is -19°C. The region receives on average 452mm of precipitation annually, most occurring as rainfall between May and September. The upland of Candle Lake drains via the Torch and White Gull Rivers east to the Saskatchewan River system. Grey Luvisolic and Eutric Brunisolic soils dominate the area and the landscape is a rolling morainic plain of glacial tills overlain with sandy sediments (*Acton et al. 1998*).

The Ecozone is home to various species (see figure 13 on page 71). The forests of the upland areas and watershed are dominated by trembling aspen (*Aspen tremuloides*) and white spruce (*Picea glauca*) with significant stands of jack pine *(Pinus banksiana*) in well-drained areas and black spruce (*Picea mariana*) occurring in organic soils. The boreal forest is habitat to white-tail deer *(Odocoileus virginianus* pictured on page 58*)*, moose (*Alces alces*) and black bear (*Ursus americanus*) although elk *(Cervus canadensis*) are not uncommon in the area. The endangered woodland caribou (*Rangifer tarandus caribou*) is rare. Bird and amphibian diversity is moderate. Candle Lake once managed a commercial fishery quota for lake whitefish (*Coregonus clupeaformis*). The fishery was discontinued due to the prevalence of the parasitic cestode *Triaenophorous crassus*. Today, the watershed supports sportfishing for northern pike (*Esox lucius*), walleye (*Sander vitreus*), and yellow perch (*Perca flavescens*).

Land use in the region includes forestry for pulp and sawlogs, some agriculture, including livestock, forage crops and beekeeping. A diamond mine developing kimberlite deposits has been established approximately 40km to the south of the northern hamlet of Candle Lake in the Fort à la Corne provincial forest. In the immediate vicinity of HCEARC, little infrastructure exists save cabins and cottages around the lake some 10km south of the facility. A large area of the land is maintained and managed as a provincial park and wildlife management area. The First Nation communities of Montreal Lake and Timber Bay lie 30 and 38km, respectively, to the north.

HCEARC is the only boreal field station in Saskatchewan. The facility of HCEARC is ideally suited for environmental studies, ecological research, post-secondary, and youth education. For over 40 years, learners have participated in hands-on applied learning in sampling, data collection, testing and analysis, laboratory and field experiences, simulated conservation investigations, wilderness survival, and applied research.

The immaculate wood lily, designated an S1 species (rarest) in Saskatchewan, is termed "immaculate" because this lily lacks brown spots in the throat.


Hamilton Greenwood

Issue/s

The people and ecology of Saskatchewan and the Candle Lake region face challenges similar to those identified by the UN IPCC (*2019*). Current challenges to regional sustainability include climate change, deforestation, and cultural and economic austerity. Climate change leads to shifts in community composition and establishment of invasive species with unpredictable outcomes. For example, climate change has resulted in the wider distribution of the mountain pine beetle (*Dendroctonus ponderosae*) east of its home range in British Columbia, and infestations are now within 50km of Saskatchewan (*Invasive Species Centre 2021*). Infestations result in economic losses to forestry, and ecological effects such as soil erosion due to decimation of jack pine and white spruce forests. In addition, climate change impacts Indigenous people of the area, such as Montreal Lake Cree Nation, a land-based culture. Therefore it can be seen that climate change and resulting ecological effects have negative impacts on cultural practice, food security, and traditional medicine. The application of conservation, education and research are of critical importance to mitigate these challenges. HCEARC provides a facility for this education and research.

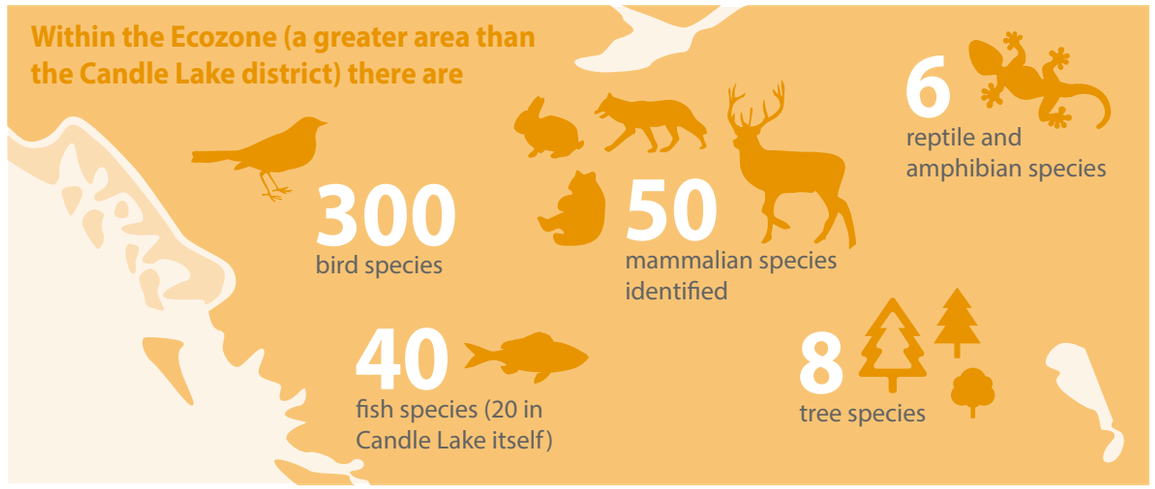
Conservation crime scene investigation research involving drones carried out in collaboration with Draganfly Innovations.

Responses/Actions Taken

Phase 1 of this RCE project was the renovation of the facilities with locally resourced materials and labour. Phase 2 was construction of a wet laboratory, which allows year-round study and applied research. Phase 3 currently involves the development of an Indigenous encampment and outdoor learning centre for Indigenous cultural experience and study, as well as a three-season greenhouse to focus on food security, which will use alternative energy sources. Students, guests and researchers have the opportunity to develop skills and investigate environmental practices for effective management of freshwater and boreal forest ecosystems. Traditional skills training includes winter survival, trapping, fishing, and canoeing. Post-secondary learners, comprised of gender-balanced cohorts that attract a significant percentage of Indigenous students, have access to the HCEARC in the spring, fall, and winter, which allows them to experience first-hand the demands of a career that requires working outdoors year-round in challenging conditions. This is in addition to education initiatives that target women and youth specifically. Women's Outdoor Weekend (WOW) events and various programmes targeting youth are held throughout the year. New technologies used in training include remote sensing with remotely piloted aircraft systems, Geographic Information Systems (GIS), and sophisticated hydro acoustic equipment. These technologies provide precision and metrics to improve resource management techniques and allow managers to respond to change in effective ways. The practical training and applied research provided in this field-based setting offers the most immediate and comprehensive route for delivery of leading-edge knowledge and skills.

Local Indigenous students participate in a fish identification workshop during the Stewards for the Land program held at HCEARC.

Figure 13. Various species identified in the Ecozone. (Source: Acton et al. 1998).



Results

Hundreds of learners from post-secondary institutions, youth groups, and NGOs attend the camp centre annually for training and education in sustainability, conservation and resource management or research. The laboratory facilitates data collection, sample analysis, applied research and hands-on learning for students, managers, and investigators in the field of resource management. The centre allows visitors to connect with natural ecosystems in hands-on activities involving water resources (water quality, recreation, and fish, e.g. Lake Sturgeon), forestry, botany (e.g. documentation of the provincially rare immaculate wood lily (*Lilium philadelphicum var. andinum forma immaculata*), and wildlife (e.g. evening grosbeak (*Coccothraustes vespertinus*) which has suffered a population decline of more than 75% in 40 years). These visitors return to their communities with deeper understanding and value for natural systems and sustainability issues which threaten them. Visitors become stakeholders in sustainability and the experience enables them to implement their education in local efforts of conservation and environmental monitoring.

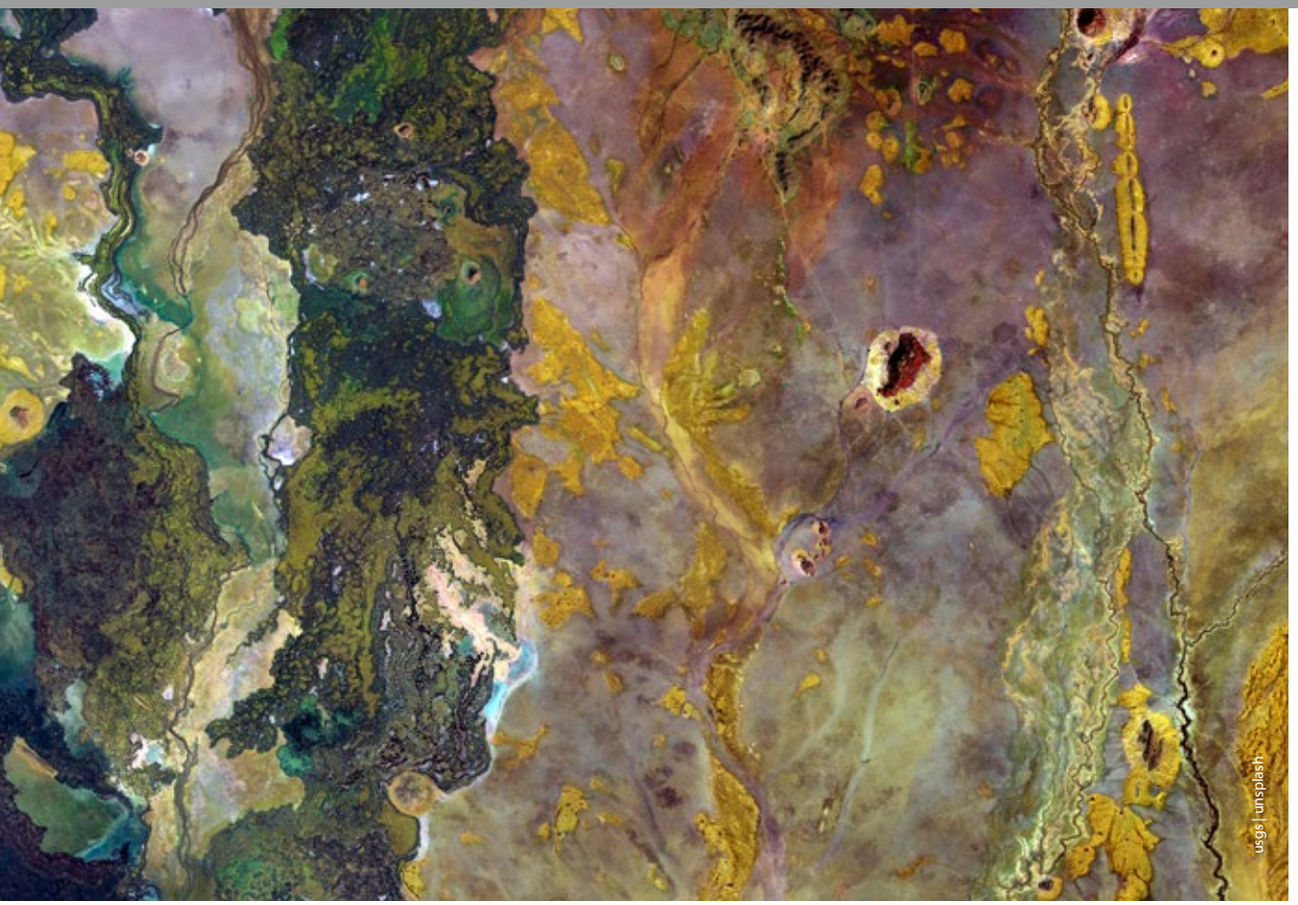
Reclamation research conducted in collaboration with Reclaimit Ltd. at Hannin Creek Education and Research Facility.

Actions to Take:

Ecologically speaking, it is understood that habitat is key for healthy populations. HCEARC provides environmental education and understanding on how to effectively manage and protect whole habitats so individual species within them can thrive. Likewise, communities rich in partnerships and relationships are robust and more resilient to environmental challenges. HCEARC operates as a hub for stakeholders committed to conservation, education, and sustainability.

More Information:

- Hannin Creek Education Centre
- Saskatchewan Polytechnic - Applied Research and Innovation



Next Steps

Dr. Philip Vaughter, Research Fellow, UNU-IAS

The projects profiled in this publication represent a step forward in education to protect the biosphere. Too often in education, theory and knowledge are de-coupled from applied action in the utilisation of skills learned – but not practiced – in formal curriculums within confined classroom settings. By bridging curriculum development with applied action for conservation in the field, these projects showcase that school systems and universities can apply workable solutions to biodiversity loss, going beyond generating knowledge to implement conservation and restoration in different ecosystems around the world. By bridging formal and non-formal education, the RCEs featured showcase that adding public awareness and action to formal education initiatives multiplies conservation actors and ensures that children and young people are not left to shoulder the impact of the sixth extinction on their own. In some ways, this emphasis on non-formal education as a multiplier for conservation action is a return to basics. The latter half of the 20th century had a number of public awareness campaigns in a number of countries that spawned effective legislation to protect both species and habitats around the world (*Hays 2020*). However, these campaigns have become more marginalised in recent decades due to an over-saturated social media landscape as well as an increasing focus on public health and other social issues with governments (*Fairchild et al. 2018*).

In addition to bridging formal and non-formal education, the projects highlighted in this publication demonstrate the necessity of working with communities on creating and implementing workable solutions for protecting the biosphere. The idea that effective conservation strategies must come from an external expert is at best a naïve assumption. At its worst, it is a dangerous assumption, in that it does not utilise the vital knowledge local stakeholders have on their environment, and risks alienating the very group from which conservation planners and policy makers need the most buy-in from. Indigenous communities around the world have been living for centuries within the forests, plains, and wetlands that are now classified as biodiversity hotspots. These Indigenous communities have critical insights into the management and conservation of ecosystems they inhabit, and engagement with these communities must be prerequisite for conservation planners. As evidenced by the project from RCE Guatemala, the Mayan communities the university worked with had a more comprehensive systems-thinking approach to the management of riverbanks that incorporated hydrology, biodiversity, and the communities and their local economies along the rivers as opposed to the siloed thinking of hydro-electric planners within the country. Local community knowledge does not have to be centuries-old to be of great value for conservation, however. Many individual households RCE South Rift worked with near the Maasai Mara had good individual practices to reduce waste and increase fuel efficiency in order to better protect habitat and biodiversity in the region – these practices just needed to be shared and scaled up.

In situations when communities may not have clear insights into the best ways forward for conservation of local ecosystems, it is still critical that conservation scientists and policy makers understand what is driving their actions, as these are stakeholders embedded within the communities. As RCE Greater Pwani showcases, an inefficient bureaucracy around transfer of land title may seem like an annoyance to some, but when coupled with climate change and a system that excludes many women as landowners, has had the real-world consequence of creating a surge of farms and villages on land that has been set aside as a biosphere reserve. The movement and economic activity of communities does not exist in a vacuum, and therefore it is critical for policy makers to understand behaviour that puts the biosphere at risk, and respond by creating enabling environments for people to change their behaviours while protecting these natural habitats. As RCE Greater Pwani points out in their project, it is critical for decision makers to understand moving these communities back to their previous landholdings is not workable in the face of a changing climate that makes these lands difficult to farm, as well as a land transfer system that excludes a large portion of citizens. To protect the forested highlands, a new way forward must be envisioned and implemented that takes this reality into account. In cases like this, learning the root of the problem is the first critical step in creating workable solutions.

The need for communities themselves to learn about the critical importance of biodiversity in their regions is also at the heart of many of the RCE projects featured. While community members can hold critical knowledge in regard to biodiversity, not all community members may have working knowledge about the tapestry of life they are embedded in, and the role that local organisms play in the ecological systems they depend on. This is especially true in many highly industrialised countries, where several decades of industrialisation has left many people completely detached from an understanding of local ecology. This need for citizens to understand the role that native biodiversity plays in supplying the air, water, and land they depend on is emphasised in the project from RCE Warsaw Metropolitan. Denizens from the surrounding city were the targeted learners in order to better embed an understanding of how the urban metabolism of the metropolitan area was dependent upon the surrounding hinterlands. The project from RCE Saskatchewan takes this same

approach through the teaching of active resource management and biodiversity conservation in a rural setting. And RCE Tongyeong's project flips the script on this, stressing how human actions can impact other species, which in turn creates a cascade effect in the environment which can impact humanity. All of these projects use hands-on learning to stress the vital importance that local and regional biodiversity plays in supporting human life and society.

Perhaps one of the great tragedies of the Anthropocene is that while much of the natural world is disappearing at a startling rate, a large portion of humanity seems at best unaware and at worst unconcerned about how our own actions play into an extinction event. While embedded social and economic structures in many societies do make it difficult for individuals or communities to enact changes at the scale needed to protect the biosphere, many of us and many of our communities have surrendered any agency that the sum total of our actions creates these societies and economies. The idea that many individual actions can create change at a massive scale was seized upon with great success by the public health community during the COVID-19 pandemic. Individually, masking and social distancing may have little impact on its own for one individual, but multiplied over the millions of individuals who complied with these public health measures, the net effect of these individual actions likely saved countless lives. The idea of mass action and taking initiative has fallen out of favour recently in environmental education or action for sustainability. The notion that 'I don't care if you recycle' and similar refrains that individual actions and initiatives are meaningless have become popular among both academics and activists who urge us to pull at social levers while ignoring the actions of our own communities, or our own households, or ourselves. But why not both?

There is no rule stating that we cannot leverage our governments and the corporations that we buy from while also learning about how our own actions may impact the biosphere and how we can change behaviours to remedy this and even restore ecosystems. These RCE projects highlight that by linking education to action, actions can be upscaled to whole communities, which leads to better conservation outcomes in a variety of habitat types. Individually, any of these learners may have contributed to actions that had an impact in conserving local biodiversity. But as with the public health mandates from COVID-19, collectively, these education initiatives have created change that have better protected habitats and the species within them. In a world where environmental issues such as climate change and biodiversity loss appear to be low priorities among many democracies' voting publics (*Kvaløy et al. 2012; van Vierssen et al. 2020*) these education projects represent vital actions local communities can take in response to the Anthropocene extinction. Furthermore, concern for a given habitat or species may be influenced by proximity to it (*Wilkins et al. 2019*), and therefore, a regionalised response may be the most appropriate intervention. By contextualising a global extinction crisis within the threats faced to local ecosystems and the concrete actions people residing in these ecosystems can take to address these threats, these RCE projects not only offer education, but agency to these communities. While the Anthropocene extinction is a global event, all interventions to stop it need local actors to implement appropriate solutions to protect the ecosystems and constituent biodiversity in their regions. These projects offer some blueprints to do exactly that.

List of Abbreviations

CBD	Convention on Biological Diversity
CENDAL	Centre for Development and Advanced Learning (Zaria)
CEPA	Communication, Education, and Public Awareness
CHEN	Cattai Hills Environment Network
CMAASC	Community Based Mangrove Agro-Aqua-Silvi-Culture
CMO	Commission on Higher Education Memorandum Order
CS	Commercial Shrimp
DENR	Department of Environment and Natural Resources
ENSDA	Ewaso Nyiro South Development Authority
ESD	Education for Sustainable Development
GBM	Ganges, Brahmaputra, and Meghna
GEEP	Grupo de Estudos de Elasmobrânquios do Paraná
GIS	Geographic Information System
GSLN	Greater Sydney Landcare Network
HCEARC	Hannin Creek Education and Applied Research Centre
HNRWA	Hawkesbury-Nepean Riverkeepers Waterkeeper Alliance
IBA	Important Bird and Biodiversity Areas
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPLC	Indigenous Peoples and Local Communities
IUCN	International Union for Conservation of Nature
KFBR	Kampinos Forest Biosphere Reserve
KFS	Kenya Forest Service
KPN	Kampinos National Park
KWS	Kenya Wildlife Service
MOU	Memorandum of Understanding
NBSAP	National Biodiversity Strategy and Action Plan
NEMA	National Environment Management Authority
NGO	Non-Governmental Organisation
NMK	National Museums of Kenya
PBCFI	Philippine Biodiversity Conservation Foundation Inc.
PISA	Programme for International Student Assessment
PKSFA	Purok Kakahuyan Small Fishermen Association
PPGSIS	Postgraduate Program in Systematics, Use and Conservation of Biodiversity
PVA	Participatory Vulnerability Assessment
RCE	Regional Centre of Expertise on Education for Sustainable Development
SDGs	Sustainable Development Goals
SSC	Species Survival Commission
STDM	Social Tenure Domain Model
UFC	Federal University of Ceará
UFPR	Federal University of Paraná
UNESCO	United Nations Educational, Scientific, and Cultural Organization
WOW	Women's Outdoor Weekend

ESD for 2030 Priority Action Areas

Priority Action Area 1	Advancing policy
Priority Action Area 2	Transforming learning and training environments
Priority Action Area 3	Building capacities of educators
Priority Action Area 4	Empowering and mobilizing youth
Priority Action Area 5	Accelerating local level actions

References

EDITORIAL

Barnosky, Anthony D., James H. Brown, Gretchen C. Daily, Rodolfo Dirzo, Anne H. Ehrlich, Paul R. Ehrlich, Jussi T. Eronen, Mikael Fortelius, Elizabeth A. Hadly, Estella B. Leopold, Harold A. Mooney, John Peterson Myers, Rosamond L. Naylor, Stephen Palumbi, Nils Chr Stenseth, and Marvalee H. Wake. 2014. Introducing the Scientific Consensus on Maintaining Humanity's Life Support Systems in the 21st Century: Information for Policy Makers. The Anthropocene Review, 1(1), 78-109.

Convention on Biological Diversity (CBD). 2020. Global Biodiversity Outlook 5. Secretariat of the Convention on Biological Diversity.

Ceballos, Gerardo, Paul R. Ehrlich, and Peter H. Raven. 2020. Vertebrates on the Brink as Indicators of Biological Annihilation and the Sixth Mass Extinction. Proceedings of the National Academy of Sciences, 117(24), 13596–13602. Retrieved from https://doi.org/10.1073/pnas.1922686117

Dasgupta, Partha. 2021. The Economics of Biodiversity: The Dasgupta Review: (Updated: 18 February, 2021). HM Treasury.

Food and Agriculture Organization (FAO). 2019. The State of the World's Biodiversity for Food and Agriculture. FAO Commission on Genetic Resources for Food and Agriculture Assessments. (p.572). Retrieved from http://www.fao.org/3/CA3129EN/CA3129EN.pdf

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). 2019. Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat. (p. 56).

Organisation for Economic Co-operation and Development (OECD). 2020. Biodiversity and the Economic Response to COVID-19: Ensuring a Green and Resilient Recovery (OECD Policy Responses to Coronavirus). Organisation for Economic Co-operation and Development. Retrieved from https://www.oecd.org/coronavirus/policy-responses/biodiversity-and-the-economic-response-to-covid-19-ensuring-a-green-and-resilient-recovery-d98b5a09/

Pimm, Stuart L., Clinton N. Jenkins, Robin Abell, Thomas M. Brooks, J. L. Gittleman, Lucas N. Joppa, P. H. Raven, Callum M. Roberts, and Joseph O. Sexton. 2014. The Biodiversity of Species and Their Rates of Extinction, Distribution, and Protection. Science, 344(6187), 1246752–1246752. Retrieved from https://doi.org/10.1126/science.1246752

Pimm, Stuart L., Gareth J. Russell, John. L. Gittleman, and Thomas M. Brooks. 1995. The Future of Biodiversity. Science, 269(5222), 347–350. Retrieved from https://doi.org/10.1126/science.269.5222.347

Tollefson, Jeff. 2020. Why Deforestation and Extinctions Make Pandemics More Likely. Nature, 584(7820), 175–176. Retrieved from https://doi.org/10.1038/d41586-020-02341-1

World Economic Forum (WEF). 2021. The Global Risks Report 2021: 16th Edition. Insight Report. [In partnership with Marsh McLennan, SK Group and Zurich Insurance Group]. World Economic Forum.

World Wide Fund for Nature (WWF). 2020. Living Planet Report 2020 – Bending the Curve of Biodiversity Loss. WWF.

ASIA-PACIFIC

RCE Tongyeong

Tongyeong City Government. Tongyeong City Environmental Preservation Plan (2021-2025). Table 14. Retrieved from https://www.tongyeong.go.kr/00001/00139/00229.web (*Data translated from Korean to English*).

RCE Sundarbans

Rahman, M. R., & M. Asaduzzaman. 2010. Ecology of Sundarban, Bangladesh. Journal of Science Foundation, 8(1-2), 35-47.

Titumir, R. A. M., Afrin, T. and Islam, M. S. 2020. Traditional Knowledge, Institutions and Human Sociality in Sustainable Use and Conservation of Biodiversity of

the Sundarbans of Bangladesh, in O. Saito et al. (eds.), Managing Socio-ecological Production Landscapes and Seascapes for Sustainable Communities in Asia, Science for Sustainable Societies, https://doi.org/10.1007/978-981-15-1133-2_5

RCE Cebu

Seriño, Moises Neil, Julie Carl Ureta, Jayson Baldesco, Karl John Galvez, Canesio Predo, and Eunice Kenee Seriño. 2017. Valuing the Protection Service Provided by Mangroves in Typhoon-hit Areas in the Philippines. EEPSEA Research Report No. 2017-RR19. Economy and Environment Program for Southeast Asia, Laguna, Philippines. Retrieved from https://eepseapartners.org/wp-content/uploads/2021/01/Valuing-the-Protection-Service-Provided-by-Mangroves-in-Typhoon-hit-Areas-in-the-Philippines.pdf

RCE Greater Western Sydney

Australian Platypus Conservancy. Distribution & Numbers. Retrieved in September 2021 from https://platypus.asn.au/distribution-numbers/

New South Wales Department of Primary Industries (NSW DPI). 2006. Aquatic Biodiversity in the Hawkesbury-Nepean Region. [An extract from: NSW DPI. 2006. Reducing the Impact of Road Crossing on Aquatic Habitat in Coastal Waterways – Hawkesbury-Nepean, NSW, Report to the New South Wales Environmental Trust, NSW DPI, Flemington, NSW]. Retrieved from https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0018/634032/Hawkesbury-Nepean_Aquatic-biodiversity.pdf

AFRICA

RCE Zaria

Food and Agriculture Organization (FAO). 2020. Land Use/Land Cover and Forest Cover Mapping in Nigeria. Abuja. Accessed from https://doi.org/10.4060/cb1327en on 24 August, 2021

RCE South Rift

Spagnuolo, Olivia S.B, Julie C. Jarvey, Michael J. Battaglia, Zachary M. Laubach, Mary E. Miller, Kay E. Holekamp, and Laura L. Bourgeau-Chavez. 2020. Mapping Kenyan Grassland Heights Across Large Spatial Scales with Combined Optical and Radar Satellite Imagery. *Remote Sensing*, 12(7):1086. Table 4. Retrieved from https://doi.org/10.3390/rs12071086

RCE Greater Pwani

County Government of Taita Taveta (CGTT). 2018. Taita Taveta County Integrated Development Plan 2018-2022. Retrieved on 25 August, 2021 from http://repository.kippra.or.ke/handle/123456789/2360

East African Natural History Soceity (EANHS). 2017. Taita Hills. Retrieved on 23 August, 2021 from https://naturekenya.org/2017/07/10/taita-hills-iba/

Mkuzi, Hamisi Tsama. 2020. "Assessment of Land Tenure, Land Use and Land Cover Changes in Taita Hills Forest Fragments: A Case Study of Ngerenyi Forest Fragments in Taita Taveta County, Kenya". (Masters Thesis, Pwani University, 2020).

Mwakumanya, Maarifa Ali, Mwikamba Maghenda, and Hamida Juma. 2016. Socio-economic and environmental impact of mining on women in Kasigau mining zone in Taita Taveta County. Journal of Sustainable Mining, 15(4), 197-204.

Pellikka, Petri, Barnaby Clark, Alemu Gosa, Nina Himberg, Pekka Hurskainen, Eduardo Maeda, James Mwang'ombe, Loice Omoro, and Mika Siljander. 2013. Agricultural Expansion and Its Consequences in the Taita Hills, Kenya. Developments in Earth Surface Processes, 16:165-179.

EUROPE

RCE Warsaw Metropolitan

Andrzejewska, Anna, Anna Klębowska, Danuta Pepłowska-Marczak, Dawid Marczak, and Grzegorz Okołów. 2020. Kampinos National Park. Accessed on 20 January, 2020 from https://www.kampinoski-pn.gov.pl/do-sciagniecia/%20file/%20225-kampinos-national-park-english%20version

Kalinowska, Anna, & Anna Batorczak. 2014. Różnorodność biologiczna to także my (Biodiversity it is also Us). Warsaw: The Earth and People Foundation.

Owadowska, Edyta, Anna Andrzejewska, Jan Danyłow, Anna Kębłowska, Dawid Marczak, Adam Olszewski, and Danuta Pepłowska-Marczak. 2013. Kampinos Forest Biosphere Reserve. Accessed on 6 October, 2021 from https://www.researchgate.net/publication/285593621_Kampinos_Forest_Biosphere_Reserve

RCE Helsinki Metropolitan

Bilz, Melanie, Shelagh Kell, Nigel Maxted, and Richard Lansdown. 2011. European Red List of Vascular Plants. Luxembourg: Publications Office of the European Union.

Finnish Biodiversity Information Facility. Species search. Retrieved on 6 September, 2021 from https://laji.fi/en/taxon/list?informalGroupFilters=MVL.343&onlyFinnish=true

Rassi, Pertti, Esko Hyvärinen, Aino Juslén and Ilpo Mannerkoski. (Eds.) 2010. The 2010 Red List of Finnish Species. The Ministry of the Environment & Finnish Environment Institute. Helsinki. Retrieved from https://helda.helsinki.fi/bitstream/handle/10138/299499/Suomen%20lajien%20uhanalaisuus%202010%2C%20sivut%201-180.pdf?sequence=1&isAllowed=y

AMERICAS

RCE Guatemala

Ministerio de Ambiente y Recursos Naturales (MARN) & Agencia de Cooperación Internacional del Japón (JICA). 2017. Manual de Educación Ambiental Sobre el Recurso Hídrico en Guatemala. Ministerio de Ambiente y Recursos Naturales. Guatemala. Retrieved in August 2021 from https://www.marn.gob.gt/Multimedios/7419.pdf

RCE Curitiba-Paraná

Agostinho, Angelo A., Fernando M. Pelicice, Ana C. Petry, Luiz C. Gomes, and Horácio F. Júlio Jr. 2007. Fish Diversity in the Upper Paraná River Basin: habitats, fisheries, management and conservation. Aquatic Ecosystem Health & Management, 10(2), pp.174–186. doi: https://doi.org/10.1080/14634980701341719

Garrone-Neto, Domingos, Vidal Haddad Jr., and Otto B.F. Gadig. 2014. Record of Ascending Passage of Potamotrygonid Stingrays through Navigation Locks: implications for the management of non-native species in the Upper Paraná River basin, Southeastern Brazil. Management of Biological Invasions, 5(2), pp.113-119. doi: http://dx.doi.org/10.3391/mbi.2014.5.2.04

RCE Sasktachewan

Acton, Donald F., G. A. Padbury and Colette T. Stushnoff. 1998. The Ecoregions of Saskatchewan. Regina, Saskatchewan: Great Plains Research centre.

IPCC. 2019: Summary for Policymakers. In: *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems* [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press.

Invasive Species Centre. 2021. Mountain Pine Beetle (Dendroctonus ponderosae). Retrieved on 19 July, 2021 from https://www.invasivespeciescentre.ca/invasive-species/meet-the-species/invasive-insects/mountain-pine-beetle/

NEXT STEPS

Fairchild, Amy L., Ronald Bayer, Sharon H. Green, James Colgrove, Elizabeth Kilgore, Monica Sweeney, and Jay K. Varma. 2018. The Two Faces of Fear: A History of Hard-hitting Public Health Campaigns Against Tobacco and AIDS. American Journal of Public Health, 108(9), pp.1180-1186.

Hays, Samantha N. 2020. Failing the Fight: The Historical Context of US Environmental Conservation and How Endangered Species are Mismanaged in the Current Legislature (Doctoral dissertation, University of Missouri--Kansas City).

Kvaløy, Berit, Henning Finseraas, and Listhaug, Ola. 2012. The Publics' Concern for Global Warming: A Cross-national Study of 47 Countries. Journal of Peace Research, 49(1), pp.11-22.

van Vierssen Trip, Nyssa, Victoria J. MacPhail, Sheila R. Colla, and Beatrice Olivastri. 2020. Examining the Public's Awareness of Bee (Hymenoptera: Apoidae: Anthophila) Conservation in Canada. Conservation Science and Practice, 2(12), p.e293.

Wilkins, Emily J., Wilson Sinclair, Holly M. Miller, and Rudy M. Schuster. 2019. Does Proximity to Wetlands Matter? A Landscape-level Analysis of the Influence of Local Wetlands on the Public's Concern for Ecosystem Services and Conservation Involvement. Wetlands, 39(6), pp.1271-1280.

Authors

FOREWORDS

Foreword by UNU-IAS
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