International Office for Water

Showcasing ecological engineering case studies

FRIBOURG-BLANC Benoît
MADEC Camille
MAGNIER Julie

April 2018

International Office for Water

www.iowater.org

Title : Showcasing ecological engineering case studies

Author(s) : FRIBOURG-BLANC Benoît, MADEC Camille (IOWater), MAGNIER Julie (IOWater), IOWater)

Contributor(s) : Collins T. (National Park Service, Buffalo National River), Bartlett C. (SPCGIZ), Denac D. (DOPPS), Connop S. (University of East London), Päivinen J. (Metsähallitus), Tonneijck F. (Wetlands International), Asjes A. (Land Life Company), Ereifej L. (WWF Hungary), Perez Manjon S. (Devesa Albufera – Valencia), French Ecological Engineering Resource Center and members of the Technical and Scientific Committee

Editor : International Office for Water (IOWater)

Publication date : 01/10/2018

Key words : ECOLOGICAL ENGINEERING, BIODIVERSITY, STREAM RESTAURATION, LAND DEVELOPMENT, CLIMATE CHANGE, RISK MANAGEMENT, BLUE CORRIDOR, GREEN CORRIDOR, ECOMIMICRY, FLOOD PLAIN, MANGROVE, CORAL REEF, GREEN ROOF, BROWNFIELD SITE, MIRE, COASTAL DUNE, FEEDBACK

Format : PDF

Identifier : OIE/34153

Language : en

Spatial coverage : EUROPE, USA, OCEANIA, INDONESIA, MEXICO

URL : https://www.oieau.fr/eaudoc/notice/Showcasing-ecological-engineering-case-studies

International Office for Water

Summary

This document gathers the factsheets produced as part of a work to showcase ecological engineering case studies.

More specifically, this work aimed to gather new case studies in Europe and at international level and to promote them. These case studies will in particular feed French and international actors, in terms of ecological engineering implementation, from a technical (dimensioning, materials, etc.) and operational point of view (project leaders, strengths and weaknesses, difficulties encountered, etc.).
Each factsheet details a particular project with specific objectives. They were prepared in interaction with the project leaders and with the technical support of the French Ecological Engineering Resource Centre. Special attention has been paid to collect the most detailed technical and scientific information available on each project.

To select the projects, the following definition of ecological engineering was chosen: *ecological engineering is defined as all actions by and / or for the living included in an engineering project.* (A-Igeco).

International Office for Water

Prescribed fires at Buffalo National River

N°1

IN A NUTSHELL

Identity of the organisation

Organisation: U.S. Department of the Interior, National Park Service, Buffalo National River

Website: https://www.nps.gov/fire/wildland-fire/connect/regional-programs/midwest.cfm

Contact: Tony Collins – Arkansas National Parks Group Fire Management. Email: tony_collins@nps.gov,Tel:870-365-2772

Site identity

Site: Buffalo National River

Location: North Central Arkansas, Ozark Highlands Region, USA

Specificities: Eroded sandstone, limestone and dolomite and the karst geology create a rich and diverse landscape supporting a variety of plant and animal species. The oak savannas, open landscape dominated by oaks, are one of the most important landscapes in this site.

Challenges: Restoration of fire as a component of natural processes. "Mimicking nature" is the greatest challenge. Restoring oak savannas ecosystems which are fire-dependent, but have been endangered by the suppression of fire these past years. Other challenges include funding, smoke management, and public opinion.

Status: The area has been designated as a national park. Approximately 37,000 of the 100,000 acre park has additionally been designated by congress as "Wilderness". Wilderness areas are the most protected landscapes in America by law.

Areas: Woodland area, Aquatic environment (rivers), Agriculture area.

Action type: Management, Restoration or rehabilitation (towards the ecosystems historical trend or repairing key functions).

Action framework: Climate change adaptation, Management of nature areas, Risk management, Land planning, Blue and green corridors.

History and context

For thousands of years naturally and human-ignited fires have influenced the landscape of the area that is now Buffalo National River, effecting the composition, structure, and distribution of vegetation throughout the area.

But, over the past century the purposeful exclusion of fire from the landscape has caused unanticipated changes. Changes in fire frequency (less frequent fires) have allowed for encroachment of woody plants into areas which were previously sparse woodlands or glades. This leads to an increasing of tree density and to canopy closure. The increase in vegetation density also represents an unnatural accumulation of fuels, altered composition and spatial patterns of vegetation, altered succession of vegetation, and increased risk to ecological and social values within and outside of the national park. Ecological values at risk from the exclusion of fire include keystone ecosystem elements such as biodiversity, resistance, and overall ecosystem health. Social values-at-risk include life, property, and human health. For a number of reasons naturally occurring fires being allowed to burn across the landscape is not feasible. Prescribed or controlled fire is used to safely reintroduce and maintain fire as a component in natural ecological processes.

Collared Lizard. Source: National Park Service

Presentation of the project

Issues and objectives

The objectives are:

- Restore and maintain fire to naturally occurring levels as a component of ecosystem processes.
- Reduce the unnatural build-up of fuels to reduce the risk of an unplanned and possibly catastrophic wildfire.
- Restore ecosystem function to maintain and improve the habitat for a variety of native species. Species that benefit from prescribed fires include Collared lizard, several bat species (such as the Ozark big-eared bat (*Corynorhinus townsendii* Cooper), Indiana bat (*Myotis sodalist* Miller & Allen), native wildflower such as Newton's Larkspur, the Purple beardtongue, Silky aster, Fringed puccoon, or bird species such as Prairie warbler, Painted bunting, Ruby-throated hummingbird, Great-crested flycatcher, Pine warbler, Indigo bunting, Eastern bluebird, Summer tanager, Greater roadrunner, Blue-gray

gnatcatcher, Yellow-breasted chat, Eastern towhee, Field sparrow or Norther flicker. Bush's poppy mallow, Newton's Larkspur, *Delphinium newtonianum*, Trelease's larkspur *Delphinium treleasei*, Ozark Corn Salad *Valerianella ozarkana*, Ozark Spider Wart, Ozark trillium, *Tradescantia ozarkana, and* Purple beard-tongue *Penstemon cobaea* are also rare Ozark endemics that benefit from fire. Fire will also help by prevent encroachment of some non-native plants such as red cedar, *Juniperus virginiana* (native tree but aggressive and has overpopulated the area) Mimosa *Albizia julibrissin*, Japanese Honeysuckel, *Lonicera japonica,* Tall Fescue, Lespedeza *Lespedeza cuneata*, Kduzu, and many others.

Creation, restoration methods

Park managers and botanists working for the Arkansas Natural Heritage Commission began to recognize that exclusion of fire from ecosystems that had evolved with fire as a natural disturbance was resulting in dramatic vegetation changes. Dendrochronology (tree ring dating) was used to establish a fire return interval for the park area. Then the current fire return interval was compared with the historic return interval to assess how significantly the fire regime had been altered by fire suppression... It was determined that the return interval had been relatively consistent from the 1600s up to the parks establishment in 1972 (about 3 to 5 years). At this point the fire return changed significantly with active suppression fire disappeared from the landscape (change in cultural values). This alteration in the fire regime allowed for encroachment of woody plants into areas which were previously sparse woodlands (oak savannas for example) or glades. The groundwater hydrologic budget also changed as more forest allows less runoff during periods of high precipitation, but also draws substantially more water from the soil horizons during periods of low precipitation. Prescribed fire is the only logical solution.

It should be noted that for some invasive plant species like the red cedar, forest managers often try to control it through slash-pile techniques: mechanical or manual cutting and then piling up of vegetation debris, and finally setting the pile on fire.

Using existing scientific information (see attached list of publications) and careful fire monitoring, prescribed fire is applied to several thousand acres annually at Buffalo National River (8,000 to 22,000 acres each year). The application of fire is conducted on predefined burn units ranging in size from 20 to more than 12,000 acres. Burn units are typically defined by pre-existing features that can be used as fire control lines such as a road or stream.

Researchers recommended frequent (2-6 years) prescribed fire application during a savanna/woodland restoration phase, then allowing occasional recruitment of oak and hickory sprouts into the canopy with burns spaced at 10-20 years.

Human and material resources

Individual treatments may be executed at any time of the year as long as fuel and weather conditions are within the fire environmental prescription perimeters listed below.

Temperature (Fahrenheit)	35° – 90°	
Remative Humidity	18% – 75%	
Wind direction	0 - 360	
Wind Speed (Mid Flame MPH)	0 – 9	
Fuel moisture – 1 hour	5 – 10%	
Live Herbaceous Fuel Moisture	60% – 300%	
Mixing Height (minimum)	3,500 ft	3,000 ft
Transport Wind (minimum)	9 mph	10 mph

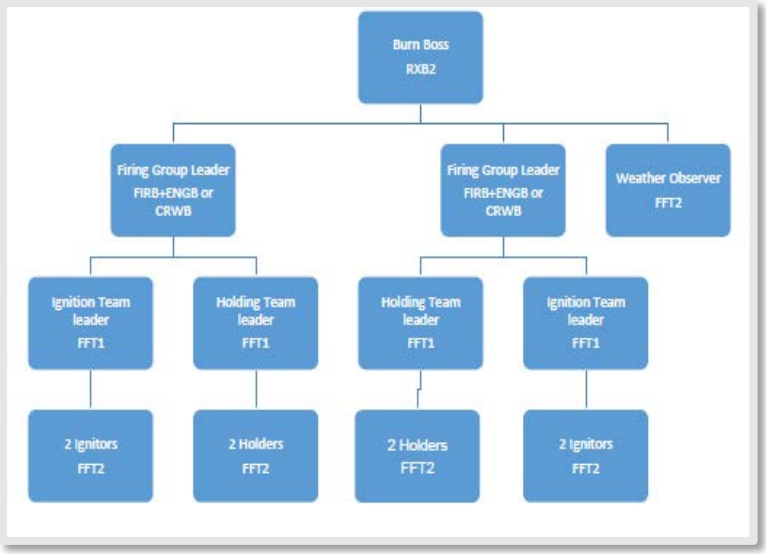
However, restrictions during events or during times of high visitor use may limit implementation. Individual treatment operations normally require 1-2 operational shift for ignitions and 1-3 operational shifts for monitoring, holding or mop-up.

All positions must meet National Wildland Fire Coordination Group Standards (www.nwcg.gov).

Generally, the minimum personnel required consist of 16 core individuals comprised of:

1 burn boss, (RXB2) 1 Firing Boss (IGSP), 2 igniters (FFT1 or 2), 1 Holding Boss (Single Resource Boss) 2 Engine Bosses (ENGB) and 9 Firefighters (FFT2). These numbers will increase as the operational complexity of the burn dictates or the number of perimeters fired increases.

Below is an example of a typical prescribed fire operation arrangement of personnel.



Typical prescribed fire operation arrangement of personnel. © Tony Collins.

All firefighters on the prescribed fire are required to have fire resistant clothing, fire pack, fire shelter, and hardhat. Equipment usually includes hand tools, gas powered leaf blowers, chainsaws, brush truck (small fire engine with 400 – 500 gallons of water) and UTVs equipped with water pump and 50 – 100 gallon water tanks.

Firing or ignition tool (©Onduso)

The type of fire used during prescribed fire is usually a "surface fire", since it increases soil fertility through converting litter into ash that immediately makes its way into the soil as nutrients. Surface fire only kills small trees with a thin cambial layer. Large trees such as black oak, with thick back, survive well under surface fire.

Surface fire at Pruitt site (©Onduso)

Usually, the Northern Forest Fire Laboratory fire model 9 is the main model used in Buffalo National River. The main characteristics are, in average (Ndar Onsuso, 2013):

— mid-flame wind speed: 5 mph

— slope: 5%

— rate of spread: 8 chains/hour (1 chain = 66 feet= 20,12 m)

— heat/unit area: 343 BTU/ft^2 (BTU: Burn unit)

— fire line intensity: 48 BTU/ft^2

— flame length: 4,8 feet.

Monitoring and evaluation methods

Vegetation is sampled prior to burning or mechanical treatment, immediately after, and at 1, 2, 5, and 10 year intervals. After collection, the data are entered into a database and stored for analysis. The data allow resource managers and scientists to compare pre- and post-burn vegetation composition and fuel loadings and assess whether burn objectives were met, and to track long-term ecosystem changes due to fire. Data is collected on the following:

- Shrub and herbaceous vegetation composition and abundance
- Tree density, diameter and health by species and size class
- Fuel load by size class (1 hr, 10 hr, 100 hr and 1000 hr fuels)
- Litter and duff depth
- Average scorch height (Post-burn)
- Percent Crown scorch (Post-burn)
- Burn Severity (Post-burn)
- Visual changes at permanent photo points

Monitoring elements were not collected on other biological compartment such as fauna, mushrooms, or soils.

- 2017 Buffalo National River Fire Effects Monitoring Report

Data analysis interpretation :

In the 9 months prior to the 2017 summer data collection, 3 woodland plots burned at BUFF in the Cecil Cove prescribed burn but no other monitoring plots. Also, a woodland plot in the Barn Bluff and a woodland plot in the Turney prescribed fire units reached the second growing season after the second burn, which is one of the written trigger points for fire effects data analysis at BUFF.

Hereunder are the 2017 fire effects objectives and monitoring results in Buffalo:

For the dry woodland for example, woodland data from 13 plots shows that it is 80% certain that at least a 60% reduction in the density of pole-sized trees will be achieved within 10 years of the initial prescribed fire. Also, woodland data from 13 plots shows that it is 90% certain that at least a 54% reduction in the number of live tree stems per acre will be achieved after 10 years of burning.

Prescribed fire in Buffalo National River (©Tony Collins)

Monitoring Unit	Management Objective (Restoration)	Monitoring Results (XX% confidence interval)	Objective Achieved?	Year Last Analysis Completed (Range of data years included in analysis)
BUFF, Glade/Transition	Reduce pole density (2.5 – 15 cm dbh) by 60% after 10 years of burning; (80% Confidence Interval)	Total pole tree reduction = 20% decrease (n=8 plots, 2 fires)	No, nor can they be at this point.	2013 2001-2013
	Increase the average number of native species in the herbaceous layer by at least 40% within two growing seasons after the second burn; (90% C.I.)	No change in the average number of species (per quadrat) in the herbaceous layer. (n=8 plots with 2 burns)	No, nor can the remaining 2 glade plots awaiting burn #2 achieve the goal.	2013 2001-2013
	Reduce new growth of eastern red cedar by 95% after three consecutive burns (90% C.I.)	Reduced new growth eastern red cedar by 100% (n=1 plot with 3 burns)	Yes	2016 2001-2016
BUFF, Dry Woodland	Reduce pole-sized tree density (2.5-15 cm dbh) by 60% after 10 years of burning; (80% C.I.)	60% Reduction (C.I. 80%) (n=13 plots, 9 – 10+ years after 1st fire)	Yes	2017 2001-2017
	Reduce overstory-sized tree density to open vista with a target density of 74 trees/hectare after 20 years (80% C.I.)	345 to 335 overstory tph = 3% Reduction (n=13 plots, 9 – 10+ years after 1st fire)	NA, first burns with plots were in 2004, but reaching goal is very unlikely.	2017 No 20 yr data 2001 - 2017
	Reduce live tree stems/acre by 60 % over 10 years of burning (90% C.I.)	54% Reduction (n=13 plots, 9 – 10+ years after 1st fire)	No, because no additional burns are planned before 10 years.	2017 2001 - 2017

Two precise examples are also provided below: the last available data for Dry woodland (2017) and for Glade (2016 – No 2017 BUFF glade data was collected or due to be collected).

For each box of the tables containing results, the first data is the pre-burning data, and the second is the post latest burn data (dates of burns are in the third column).

BUFF Plot Type & #	Burn Unit	Dates of burns	Written goal is 60% reduction of pole-sized trees (2.5-15cm dbh) per hectare after 10 yrs of burning (with a statistical confidence interval of 80%)	Woodland plots had no goal established for increasing the avg # of native herbaceous species. Latest data.	Written goal is to reduce tree density to open vista with a target density of 74-126 overstory-sized trees per hectacre after 20 yrs (80% C.I.)
Dry woodland 1	LBW	3/10/04, 3/30/07, plot did not burn in 13,	From 2280 to 1240 = -46%	From 1.9 to 3.5 = up 84%	From 210 to 210 = no change
Dry woodland 2	LBW	3/10/04, 3/30/07, 3/6/13,	2480 to 570 = -77%	1.3 to 6.9 = up 431%	270 to 310 = +15%
Dry woodland 3	LBW	3/10/04, 3/30/07, 3/6/13,	1760 to 320 = -82%	0.8 to 3 = up 275%	370 to 330 = -11%
Dry woodland 4	LBW	3/10/04, 3/30/07, plot did not burn in 13,	1560 to 600 = -62%	1.4 to 5.2 = up 271%	510 to 530 = +4%
Dry woodland 5	LBW	3/10/04, 3/30/07, 3/6/13,	2240 to 1200 = -46%	2.1 to 5.7 = up 171%	240 to 320 = +33%
Dry woodland 6	LBW	3/10/04, 3/30/07, 3/6/13,	1800 to 400 = - 78%	0.5 to 4 = up 700%	230 to 240 = +4%
Dry woodland 7	LBW	3/10/04, 3/30/07, plot did not burn in 13,	1680 to240 = -86%	1.8 to 2.9 = up 61%	170 to 160 = -6%
Dry woodland 8	Pruitt	3/14/05, 3/28/12, 3/22/14, 10/15/15,	1200 to 280 = -77%	4.1 to 10.9 = up 166%	360 to 260 = -28%
Dry woodland 9	Riddell	3/3/05,	1720 to 1760 = +2%	8.6 to 6.1 = down 29%	300 to 300 = no change
Dry woodland 10	Riddell	3/3/05,	1520 to 1440 = -5%	2.5 to 1.9 = down 24%	530 to 520 = -2%
Dry woodland 11	Cecil Cove	11/11/09, 1/31/17	800 to 720 = -10%	2.9 to 8.2 = up 183%	310 to 320 = +3%
Dry woodland 12	Cecil Cove	11/11/09, 1/31/17	1680 to 1240 = -26%	7.3 to 15.1 = up 107%	300 to 310 = +3%
Dry woodland 13	Cecil Cove	11/11/09, 1/31/17	800 to 880 = +10%	2.9 to 5.7 = up 97%	290 to 240 = -17%

Dry woodland 14	Turney	11/19/08, did not burn in 11 or 12, 1/28/16,	1680 to 480 = -71%	2.5 to 9 = up 260%	420 to 390 = -7%
Dry woodland 15	Turney	11/19/08, WF-4/9/11, WF-3/2/12, 1/28/16	360 to 200 = -44%	0.7 to 2.9 = up 314 %	530 to 430 = -19%
Dry woodland 16	Barn Bluff	Plot has not burned	1160 to? = ?	2.4 to ? = ?	350 to? = ?
Dry woodland 17	Barn Bluff	11/20/08, WF-2/14/16,	440 to 400 = -9%	1 to 3.3 = up 230%	340 to 360 = +6%
Average results			Avg for latest data from 16 burned plots for all poles went from 1498 to 751 = decline of 50%	Avg for latest data from 16 burned plots went from 2.6 to 5.9 = up 123%	Avg for latest data from 16 burned plots went from 336 to 327 = decline of 3%

Tableau 1: 2017 BUFF dry woodland fire management. Results from individual plots.

BUFF Plot Type & #	Burn Unit	Dates of burns	% reduction of pole-size trees per hectare based on latest data (goal is at least a 60% reduction after 10 yrs of burns)	% increase in avg # of native herbaceous species (based on latest data)	% reduction of eastern red cedar seedlings (goal is at least a 95% reduction after 3 burns)
Glade 1	Lower Buff Wilderness	3/10/04, 3/30/07, plot did not burn in 13,	From 2520 to 2000 = -20%	From 6 to 8.2 = up 37%	From 2 to 0 = -100%
Glade 2	Lower Buff Wilderness	3/10/04, 3/30/07, 3/6/13,	2640 to 2040 = -23%	6 to 9.4 = up 57%	0 to 0 = null
Glade 3	Lower Buff Wilderness	3/30/07, Plot did not burn in 04 or 13	1320 to 1200 = -9%	Only burned once 7.2 to 5.6 = down 22%	73 to 0 = -100%
Glade 4	Lower Buff Wilderness	3/10/04, 3/30/07, plot did not burn in 13,	720 to 520 = -28%	5.2 to 4.6 = down 12%	1 to 0 = -100%
Glade 5	Lower Buff Wilderness	3/10/04, 3/30/07, plot did not burn in 13,	840 to 880 = +5%	10 to 9.8 = down 2%	1 to 0 = -100%
Glade 6	Lower Buff Wilderness	3/10/04, 3/30/07, plot did not burn in 13,	2040 to 1760 = -14%	3.6 to 6.2 = up 72%	0 to 0 = null
Glade 7	Lower Buff Wilderness	3/30/07, Plot did not burn in 04 or 13	640 to 560 = -12%	Only burned once 5.4 to 4.6 = down 15%	5 to 0 = -100%
Glade 8	Lower Buff Wilderness	3/10/04, 3/30/07, plot did not burn in 13,	1320 to 920 = -30%	7.2 to 6.6 = down 8%	2 to 0 = -100%
Glade 9	Pruitt	3/14/05, 3/28/12, did not burn in 14 or 15	1360 to 200 =-85%	7.4 to 7.2 = down 3%	3 to 1 = -67%
Glade 10	Pruitt	3/14/05, 3/28/12, did not burn in 14, 10/15/15,	720 to 280 = -61%	5.4 to 15.6 = up 189%	18 to 0 = -100%
Average results			10 plot avg for all pole trees went from 1412 to 1036 = decline of 27%	10 plot native herbaceous species avg went from 6.3 to 7.8 = increase of 23%	10 plot avg went from 10.5 cedar seedlings per subplot to 0.1 = decline of 99%

Tableau 2: 2016 BUFF glade fire management. Results from individual plots.

In 2017 at BUFF, data from two customized fire effects monitoring plots established to monitor changes in a population of the nationally-rare and fire-benefitted Bush's poppy mallow (Callirhoe bushii) in the North River Road prescribed fire unit were also collected.

In 2017, the 2 plots of Bush's poppy mallow had total populations that remained above the 2014 total, (**Erreur ! Source du renvoi introuvable.**). However, the Plot #1 data compared to data initially collected in 2012 showed the Bush's poppy mallow population is still struggling to produce reproductive-sized plants, presumably due to a combination of excessive shade and herbivory by deer or elk.

Plot #2's 49 reproductive stems in 2017 is almost double the 26 counted there last year. While this is great news there was no obvious reason for this increase.

Prescribed fire in Buffalo National River (©Tony Collins)

Buffalo National River *Callirhoe bushii* (CABU4) data from North River Road prescribed burn unit											
Year & CABU4 plot #	Healthy Seedlings	Stressed Seedlings	Stress code*	Stems Healthy Vegetative	Stems Stressed Vegetative	Stress code*	Stems Healthy Reproductive	Stems Stressed Reproductive	Stress code*	Total for plot	Total for year
2012 plot #1	11	0		1	0		4	18	DH=18	34	
No 2013 visit											
2014 plot #1	23	20	DH=19 IH=1	0	0		0	0		43	
2014 plot #2	10	23	DH=23	0	9	DH=9	0	2	DH=2	44	87
2015 plot #1	92	54	DH=29 IH=18 BT=4 MD=3	0	9	DH=9	0	0		155	
2015 plot #2	78	20	DH=8 IH=12	2	11	DH=11	1	2	DH=2	114	269
2016 plot #1	10	19	DH=18 IH=1	0	1	DH=1	1	7	DH=7	38	
2016 plot #2	35	2	DH=2	1	0		14	12	DH=12	64	102
2017 plot #1	28	8	DH=8	1	0		5	9	DH=8 BT=1	51	
2017 plot #2	18	2	DH=2	1	0		47	2	DH=2	70	121
* Stress codes are used when ≥ 10% of a plants total leaf area is affected. DH = deer or elk herbivory, GH = groundhog herbivory, IH = invertebrate herbivory (snail, insect, etc.), PM = powdery mildew, BT = black tip (viral wilt, fungus, drought, or any other factor causing an unbrowsed stem to wither), HD = hail damage, MD = mechanical damage (falling tree limbs, walked on, etc.).											

Tableau 3: Bush's poppy mallow in North River Road prescribed fire unit.

The study led by Onduso (Onduso, 2013) for his research project on prescribed fire in five different sites of the Buffalo National River showed also several results (in the specific context of the study):

- There were more oaks and hickories in burned than in unburned sites (probably because fire opens up forest floor)

- Prescribed burning encourages the development of undergrowth

- The average tree height (m), tree basal area (m²/ha), and tree volume (m3/ha) were higher in burned sites

- Soil nutrients that had higher values in unburned study sites were phosphorus (P), Bray II P, calcium (Ca), and potassium (K), while total exchangeable nitrogen released per acre was higher in burned study sites. Iron ion values were lower in the

burned study sites, probably due to its rapid uptake by fast-growing herbaceous species that need it as a nutrient

- Fire had both positive and negative effects to both the biotic and abiotic environment. Among the negative points: at the

Buffalo National River, fresh wood cavities made by woodpeckers were found only in unburned sites. Moreover, there were some rare plant species encountered in the unburned study sites. Two of these were leatherwood (*Dirca palustris* L.) and rattlesnake plantain (*Goodyera pubescens* [Willd.] R. Br.)

- Fire encouraged the establishment of some species such as the fungi *Biscogniauxia mediterranea* (De Not.) Kuntze and *Valsa ceratosperma* (Tode) Maire that were present only in burned study sites, but discouraged other species

Description

Facilitation

It is required to develop a comprehensive Fire Management Plan with associated environmental compliance documentation for the park unit, a programmatic or park wide prescribed fire plan, and an incident action plan (IAP) for each prescribed fire burn operation. The IAP contains several individual plans (Ignition plan, holding plan, staffing and assignment plan, communications plan, medical plan) as well as burn unit specific safety and protection considerations. Reporting via national web-based programs is required both before and after implementation.

Partners

— Technical and Scientific: US Forest Service, The Nature Conservancy, Several Universities, local and state agencies.

— Financial: Most of the funding is federal dollars allocated annually by the US Congress to the National Inter agency Fire Centre (NIFC). NIFC distributes the funding by agency to regional offices who distribute the funds to local fire management offices such as the Arkansas National Parks Fire management Group.

Prescribed fire in Buffalo National River (©Tony Collins)

Costs and financing

It is difficult to estimate the exact cost of completing a prescribed fire projects. However a reasonable figure would be from $50 to $250 per acre.

Timetable

ACTION TIMETABLE

Year 1	Year 2 - 3	Year 3 -4	8 – 10 years
Project area is identified	Pre burn monitoring data is collected	Project is entered into National Fire Plan Operations and Reporting System (NFPORS) Funding is requested	Burn plan is updated
Area is mapped or a GIS layer file(s) are created	Monitoring plots are installed	Prescribed Fire Burn Plan is completed	Burn plan is tech reviewed, and reviewed and approved by regional fire staff.
Project area is reviewed by Resource Management Staff	Cultural and natural resource field surveys are initiated.	Burn plan is tech reviewed, and reviewed and approved by regional fire staff.	
Project area is reviewed by Fire Management Staff	Cultural and natural resource field survey reports are completed	Compliance packages are prepared and submitted for regional, state, federal, and Native American tribal review and approval	Compliance is reviewed and submitted for regional state, federal, and Native American tribal review and approval
Project area is reviewed by local Cultural Resources staff	Depending on the area and type of burn, public meetings or field trips may occur.	An Incident Action Plan is developed for the burn. Any on site pre-burn preparations are completed.	An Incident Action Plan is developed for the burn. Any on site pre-burn preparations are completed.
Site specific data is gathered prior to initiating compliance.	Research needs are established, and partners are identified	The unit is burned	
Data gaps and site specific information needs are identified	Research and data collection continue	Post burn fire effects monitoring data is collected GIS data is submitted for completed area. Fire reports are entered into the Wildland Fire Management Information database.	

Overall assessment

STRONG POINTS	WEAK POINTS
— A natural process — Fire crews are trained and have a strong experience — Actions are based on scientific information	— Emissions of CO2 and other particles that can be harmful to human health when inhaled — Some points related to social acceptance (see below).

IMPROVEMENTS - ADVISES
— Base any and all actions on the best available science and as much research as possible.

- Social acceptance

The social dynamics of prescribed burning are extensive and can be very emotional.

A project led in 2006 aimed at identifying and addressing the social constraints to the use of prescribed fire in the Ozark and Ouachita National Forests of Arkansas (Creighton and al., 2006). In order to identify the issues, a series of focused discussions were held at 6 locations across the state, with participants representing a wide range of stakeholders. Discussions were intended to identify barriers surrounding the use of prescribed fire in forest management. Three main issues which impact land manager's ability to burn were identified by participating stakeholders: risk, smoke, and public perception.

Smoke from prescribed fires was one of the foremost issues mentioned by stakeholders. Primarily, stakeholders indicated that they were concerned with the impacts of smoke on visibility, health and air quality. The effect of smoke on human health was a predominant point of discussion during all meetings.

Stakeholders named numerous potential risks associated with the use or lack of use of prescribed fire. Participants noted that there is a risk of litigation involved with the application of prescribed fire. Land managers voiced concerns about unintended visibility problems created by smoke which settles over high traffic areas such as highways and airports. For others, the risk of a prescribed fire becoming a wildfire and the potential damage to property, life, biota and ensuing litigation was of great concern. Likewise, the risk of ecosystem damage through fire suppression and the increased risk of catastrophic wildfire due to the lack of controlled burning were also mentioned by some participants.

Participants also articulated a concern about the public perception of prescribed fires in Arkansas. The participants perceived a difference between rural and urban communities regarding the acceptance of controlled burning, with rural communities having a higher degree of acceptance. They suggested that these differences would become more polarizing as urban sprawl increases in the rural areas of Western and Northern Arkansas.

Perspectives

Continuation

It is anticipated that the project will continue. Of course all work is dependent upon funding.

Transposability

It is accepted as an approach to fire as a part of restoration ecology. The application of prescribed fire to restore and maintain ecological health has been proven on private and public lands across the U.S. and in many locations worldwide. The general process is transferable. Adjustments may be necessary depending on level of expertise, risk, fuel model, topography, and climate.

Prescribed fire in Buffalo National River (©Tony Collins)

Publications

-Ndar Onduso, F., 2013. Effect of Prescribed Burning in the Forests of Buffalo National River, Arkansas. *University of Arkansas, Fayetyeville.* http://scholarworks.uark.edu/etd/1024/

-Creighton, J. H., H.O. Liechty, R. Montgomery, M. Pelkki, and T. Walkingstick. 2006. Identifying and addressing social constraints involved with the use of prescribed fire in forest ecosystems of the Ouachita and Ozark regions of Arkansas. Executive summary. https://www.uaex.edu/business-ommunities/public_policy/research_publications/exec_summary/tamara_hal_executive_summary.pdf

-Vasilyeva, Larissa N. Stephenson Steven L. Collins T.,2014, Pyrenomycetous fungi (Ascomycota) of the Buffalo National River, University of Arkansas, Fayetyeville

-Foti Thomas L., Chief of Research, Upland Hardwood Forests and Related Communities of the Arkansas Ozarks in the Early 19th Century, Arkansas Natural Heritage Commission, Little Rock, AR 72201

-Stambaugh, Michael C.,Gyette, Richard P., 2006, Fire Regime of an Ozark Wilderness Area, Arkansas, Department of Forestry, 203 ABNR Bldg., University of Missouri-Columbia 65211
http://www.bioone.org/doi/abs/10.1674/0003-0031(2006)156%5B237:FROAOW%5D2.0.CO%3B2

-Guyette R.P., Spetich , M.A.., Stambaugh, M.C., 2006, Historic fire regime dynamics and forcing factors in

the Boston Mountains, Arkansas, USA, Forest Ecology and Management 234 (2006) 293–304
https://www.sciencedirect.com/science/article/pii/S0378112706004877

-The Glades of Buffalo National River, Arkansas, J.M. Logan, Arkansas Natural Heritage Commission
https://lib.dr.iastate.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=17832&context=rtd

-Fire History of turkey Mountain, Arkansas, Dr. Richard Guyette, University of Missouri-Columbia

-Savanna and Glade Vegetation of Turkey Mountain, Buffalo National River, Arkansas: Effects of a single Prescribed Burn, S.E. Jinkins, University of Missouri-Columbia

-Resurvey of Turkey Mountain, Buffalo National River, Arkansas: Effects of Two Prescribed Burns, Jenkins and Jenkins, University of Missouri-Columbia

-Fire History, Vegetation Composition and Structure, and Fire response of Post Oak Barrens within the Lower Buffalo Wilderness USGS Missouri Field Station, University of Missouri-Columbia

Links to most research can be found at https://www.frames.gov.

Realized by: International Office for Water

With the financial support of: AGENCE FRANÇAISE POUR LA BIODIVERSITÉ ÉTABLISSEMENT PUBLIC DE L'ÉTAT

and the technical support of the French Ecological Engineering Resource Centre: Centre de ressources GÉNIE ÉCOLOGIQUE

Coral gardening in Vanuatu

N°2

IN A NUTSHELL

Identity of the organisation

Organisation: SPC-GIZ Coping with Climate Change in the Pacific Islands Region (CCCPIR) programme & Nguna-Pele Marine & Land Protected Area Network

Websites: http://www.panorama.solutions/fr/node/1408

https://www.equatorinitiative.org/2017/05/29/nguna-pele-marine-and-land-protected-area-network/

https://www.youtube.com/watch?v=nx-1LW_cXH0

Contact: Christopher Bartlett - Country Director and Technical Advisor to the Vanuatu component of the SPC-GIZ Coping with Climate Change in the Pacific Islands Region Project - christopher.bartlett@giz.de

Site identity

Localisation: Pele, Shefa Province, Vanuatu - Oceania

Challenges: Coral reefs have a role in coastal protection and in the island ecosystem functioning

Status: Marine protected area

Areas: Coastal environment

Action type: Restoration or rehabilitation (towards the ecosystems historical trend or repairing key functions), Species reintroduction, translocation

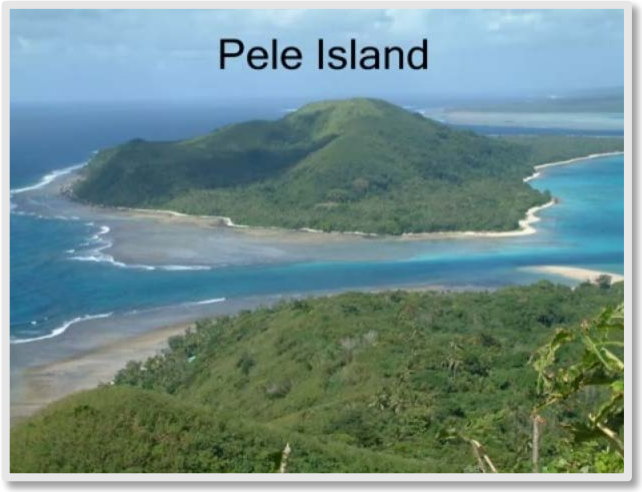
Action framework: Climate change adaptation.

History and context

Vanuatu is particularly vulnerable to the adverse effects of climate change. The inhabitants of many islands are already suffering from sea level rise and extreme weather events such as hurricanes, droughts, heavy rainfall and floods, and their effects, for example costal inundation, soil nutrient loss, and coastal & hillside erosion. The predicted rise in sea levels, altered precipitation patterns, higher temperatures and acidification of the ocean will exacerbate these risks in the coming decades. This jeopardises the livelihoods of the people, most of whom are engaged in subsistence agriculture, forestry and fishing and are thus dependent on natural resources. Extreme weather and slow onset climate events also have a particularly detrimental impact on tourism.

Another aspect of the project is the importance of coral reef for people. In Pele Island for example, the coral reef is very close to the land (fringing reef extending about 150 m from shore) and people see it very clearly when they swim, fish, etc. Because they have such close proximity, this coral reef is like a "personal" reef, a personal resource that "belongs to" them.

But beginning 10 or 15 years ago, coral reefs started to substantially degrade. In response, island people decided to do something proactive to avoid that.



Pele Island. Source: The Nguna-Pele Marine Protected Are Network

Presentation of the project

Issues and objectives

Coral reefs are currently under threat from climate change (ocean acidification, increase in ocean temperatures), invasive species (Crown of Thorns starfish) and human activities. There are also pressures due to bleaching events, storms or cyclones. This, in turn, affects their role for coastal protection and as essential food and service providers in the island ecosystem.

The objective of the program is to enable community-based coral reef climate change adaptation via an innovative and income generating ecotourism activity. This action is also obviously beneficial for the ecosystem.

7-8 years ago, people in Vanuatu heard about a group in Fiji who did some coral planting : coral were planted on concrete disks, or "cookies", woven onto heavy metal

frames with sturdy lines, and placed on underwater tables made of iron bars. So in 2005-2006, they tried to do the same in Vanuatu, with 300 coral fragments at the beginning. About 6 months later, coral was developing and growing securely onto the cookies. But because coral cookies and tables were placed only 2-3 meters deep from sea surface, a powerful cyclone destroyed everything. However, this initial action of being able to "farm" coral had already started to change people's perceptions about coral, and the way they previously saw the coral reef: a system outside of their sphere of influence.

In 2012, Pele Island experienced a severe outbreak of the coral eating starfish called Crown of Thorns. The outbreak was due to an over harvest of starfish predators, but also increased reproduction cycles due to climate-increased sea surface temperatures. Subsequent to the starfish infestation damage to the reef, and after a 2013 cyclone caused reef destruction, the island leaders decided to try coral planting again with an improved methodology. The communities also banned all fishing and harvest of the two important predators of the starfish: the Napoleon Wrasse and the Triton Trumpet shell.

Creation, restoration methods

Several steps:

- Collecting broken coral fragments in shallow waters (broken by storms, waves…);

- Attaching broken coral fragments to a cage where they can grow, with zip ties or tie wire. ;

- Transplanting corals to large coral frames where they can grow to full colonies. Coral frames are attached to cement blocks sitting on the substrate (about 30-40 cm off the sand). To avoid to be destroyed by cyclones and waves, coral beds/cages have to be installed deeper than the storm surge (about 7 meters deep). Still, some planting zones are located in shallow water, for easier access to tourists (~3 m). Corals are planted at the edge of the existing coral fringing reef (~55m wide).

Coral have to be quickly attached and brought back to the sea (a matter of hours), as coral tissue is sensitive to exposure to air or excessive handling.

A new cage is added approximately every month.

Actions have also been implemented to act on the causes of coral reefs disappearance.

Combating invasive species

A few years ago, the Nguna-Pele area was under threat from the invasive species crown-of-thorns starfish (*Acanthaster planci*). A 'land and sea clean-up campaign' was organized, as a competition between communities: in total, over 25,000 starfish were collected over a period of 1 year. For example 10 000 starfish, including 3 000 from within the Unakap village land boundary, were collected in a single Network cleanup event. Prizes were offered for teams (men, women and youth) that could collect the most starfish in a 3 day period. The winning groups spent hours and nights on the reef, collecting all of the invasive starfish to protect the reefs.

People realised that starfishes are full of nutrients (nitrogen, phosphates, potassium) and can be used as organic fertiliser so now they sell them as fertilisers. The crown of thorns starfish must be leached of all salt before they are ground up and added to soil and other organic matter. Applied to the poor sandy soils of some low lying areas, starfish compost rapidly improves agricultural production. Two families are now involved in producing starfish compost for sale.

Combating sediments

In recent years, a widespread tree-planting campaign has been carried out, as Vanuatu communities have been encouraged to help meet the challenges of climate change though targeted awareness-raising. The trees

being planted are specifically focused on coastal resilience, with plants like vetiver grass also being used to control erosion with drought resistant local varieties of sandalwood. By revegetating coastlines, these trees and grasses help stabilize sediments to ensure that they do not end up on coral reefs and smother the living organisms. Keeping sand in place on the beach through forestry also means that the tourism industry can bring much needed income to the people of the islands.

Combating destructive fishing practices

One of the most serious threats to coral reefs, in addition to climate change, is human overfishing. In this regard, the Nguna-Pele Network has established a series of no-take areas to protect breeding stocks and ensure that there is always a sufficient supply of fish and invertebrates for community consumption. Further, the Network has been working with all villages to ban unsustainable fishing practices, like using small-mesh nets (that catch juveniles) and also using spear guns at night when fish are sleeping and do not swim away. The most important innovation is to get fishermen to tap into non-reef fish stocks, for example by setting up Fish Aggregating Devices offshore so that fishermen are targeting deep water pelagics and leaving the reef system intact.

Human and material resources

Material resources

Coral is planted onto large cages or tables that are anchored into the substrate at a depth of ~7m, which is below the dangerous wave zone during cyclones. The cage material used as the base for planting coral is iron rebar (used to reinforce concrete construction) welded together to create a 1m x 2m bed. The iron rebar quickly oxidizes when exposed to sea water, but doesn't seem to affect coral growth. The small amount of iron rebar used also did not have any discernible effect on water quality. More recently, galvanized mesh wire had been used to create the beds, which is lighter and doesn't oxidize as quickly.

Coral cage – Vanuatu (©Island Reach)

Coral pieces are collected from the reef after a storm or at the wave zone of the reef, where small pieces of coral are naturally broken off due to natural wave action. The pieces are then attached to the coral beds/cages. Coral are attached with plastic zip ties or construction tie wire (not biodegradable) but in Vanuatu it may not be possible to have more natural material. However, these ties represent a relatively small part in terms of volumes of planted coral.

A lighter and more mobile version of the beds/cages was developed with support of a local NGO (Island Reach) consisting of several bent and joined pieces of iron rebar (looking like a spider walking on the sand). On a spider cage, up to 30 fragments can be put, and 100 on a bed.

As for the coral species, fast growing branching *acropora sp* is generally used, but plantation has also been successful with some branching *monitpora sp* as well as *pocillopora sp*. Not all coral species have the same survival rate when planted, this is why after trial and error only 10 species are currently collected and targeted for planting. In particular, it was noticed that certain families did very

well (*Acroporidae*, ..) while others (e.g. *Pocillopora*) did not and had very high mortality rate. In this regard, the newly reef is not representative of a natural coral reef and does not fully fulfil the same ecological functions and services as a naturally healthy reef. The new reefs do, however, provide critical reef structure and substrate for fish, invertebrates and other benthic species that require living coral to thrive.

Human resources

There has been technical support for this project, from GIZ, Island Reach, the Government of Vanuatu and others, but local communities and tourists are the main human resources over the last decade. Kids collect fragments, women attach them to the spider cages and men dive to install the cages. This program is an example where women play a proactive role in marine conservation, a sector typically implemented by men.

Tourists were interested to see what was done to protect coral, and they wanted to participate. They pay 50$US to attach a single fragment of coral on the spider cage. This money is paid in the form of an "adoption" whereby the visitors are able to claim their "own" climate resilient coral reef. The money comes back to the community and is then used for the conservation of corals and other environmental protection projects. Coral planting is the most internationally renowned attraction on Pele Island, along with sea turtles.

Construction of spider cages costs 25$US and a large bed cage costs around 45$US. These costs are fully covered by the money of tourism.

Monitoring and evaluation methods

The monitoring is based on the community capacities and interests to observe the outcomes of coral planting activities.

For the natural reef, community leaders define what a healthy coral is and then they monitor the coral to see if they are healthy or not.

For the grown reef, there is no formal monitoring method. They monitor and pay attention to the coral, removing dead ones, cleaning the reef, etc. It is a very regular visual monitoring but not a scientific one.

Fish are coming back but no monitoring is done to quantify biodiversity increase.

Coral gardening on galvanised mesh wires – Vanuatu (©CCCPIR-SPC/GIZ)

Description

Facilitation

Actions set up in the 2000s played an important role in changing local populations' mind about the biology of corals. The proactive role they can play in coral gardening also facilitated their participation.

Partners

Governance:

— Vanuatu's Nguna-Pele Marine and Land Protected Area Network is responsible for the project. The network comprises members of each village. It is also responsible for environmental education.

4 technical groups:

— Island Reach: an NGO
— A Fiji expert in coral growing.
— The Government of Vanuatu
— GIZ

Costs and financing

To start the project, GIZ brought money. But quickly, project has become self-financed, thanks to the money coming from tourism.

Timetable

Coral gardening actions are led since 20 years in the Pacific Island, and for over 15 years in Vanuatu, even if this specific project has begun in 2013.

So far, the project has no end date. It is self-financing, and there is always some need and some place available for coral gardening. Indeed, there are larger areas of reef around the island which could be further rehabilitated as beds are quite small.

The villages are in charge of the planting locations and activity.

Overall assessment

Main results

-Over 3000 coral fragments have been planted on a variety of submerged structures that proved to be robust and resilient to severe tropical Cyclone Pam.

-Eroding coastlines are stabilizing with increased coral health and wave-buffering reef development

-Planted coral varieties that are more tolerant of heat stress are becoming widespread

-Coral-associated fish, a source of local food security, are increasing in abundance

-7 island villages are receiving sustainable income flows, which are re-invested in local adaptation and environmental management projects

-Village women and girls have been empowered to proactively participate in a marine climate adaptation activity, a sector typically dominated by male fishermen and divers

-Education programs with over 500 youth about coral sensitivity to climate change has enabled more comprehensive coastal management among indigenous communities.

-Increased engagement with overseas visitors has opened doors for other forms of climate cooperation (e.g. sponsoring village water-supply systems, and construction of classrooms).

STRONG POINTS	WEAK POINTS
- One of the keys of the success was the proactive role given to the community. In protected areas, action is undertaken but is more disconnected from the community and people, whereas with this action people are really active, and they changed their perception of corals as something that can directly manage. - Involving local communities, in particular women and girls, was also a strong point: not only it acknowledges their important role in managing natural resources but it is also beneficial for coral gardening activities, as women and girls are very skilled and effective coral gardeners. - Coral planting is not a passive action, and the effects from the work can be seen. Also it is easy to do, you just have to be sure that the fragment is well fastened to the iron. Coral gardening doesn't require a lot of scientific or technical knowledge. - Another reason of success is the economic aspect: funds raised by tourism are used for other climate change projects (reef survey...), for school, and for people of the island. - Overall, the tailoring of conservation solutions to local need is a strong point of this project.	- The main negative aspect is related to the mortality rate of coral (about 30%), due to the fact that collected fragments are broken fragments, sometimes they are too damaged to survive. They can also be over handled. - Another challenge is linked to the damage that can be done by cyclones and storms, in particular category 5 storm with 5 meters waves, which are extremely powerful storms that they transport tons of sediments. In this case, people in Vanuatu have to clean coral beds. - Bleaching events and ocean acidification are also occurring due to climate change, and there is almost nothing that can be done about that. Some coral varieties are stronger than others, but they still could die from bleaching/acidification. - The fact that material for coral gardening is not biodegradable can also be a weak point for this project, even if in Vanuatu there is not many possibilities for procuring other material. - The lack of scientific monitoring can also be seen as a negative point.

IMPROVEMENTS - ADVICES

Advices
- Think about a sustainable income to make the project live by itself
- Choose a site were tourism can be possible

Improvement
-Use more sustainable material (biodegradable, or recycled)
-Set up a monitoring of the plantations and an evaluation of the actions implemented

Perspectives

Continuation

This project will continue in Vanuatu.

Government has prioritized adaptation in coastal communities in its Nationally Determined Contribution (NDC) as lodged with the UN Climate Change Convention.

Transposability

This kind of project could be transposable to other places were coral is living. But attention should be paid to the fact that the project can generate a sustainable income, and that it is done in areas where there is tourism / where conservation tours can be organised.

It could also be great to consider some education activities, to make the project a sustainable conservation tool.

Realized by: International Office for Water

With the financial support of: AGENCE FRANÇAISE POUR LA BIODIVERSITÉ ÉTABLISSEMENT PUBLIC DE L'ÉTAT

and the technical support of the French Ecological Engineering Resource Centre: Centre de ressources GÉNIE ÉCOLOGIQUE

LiveDrava - Riparian Ecosystem Restoration of the Lower Drava River in Slovenia

N° 3

IN A NUTSHELL

Identity of the organisation

Organisation: DOPPS – BirdLife Slovenia

Website: http://livedrava.ptice.si/

Contact: Damijan DENAC, director, damijan.denac@dopps.si

Site identity

Site: Lower Drava River, encompassing Natura 2000 site Drava and Ormož Basin Nature Reserve

Location: Alluvial plain called "Dravska ravan" in NE Slovenia between Maribor and Središče ob Dravi, encompassing Lake Ptuj and Ormož Basin Nature Reserve., SI

Specificities: Due to 3 hydro-power plants, natural dynamic of Drava River was heavily altered, and in Ormož wastewater basins of a Sugar Factory were abandoned.

Challenges: To preserve and enlarge populations of Natura 2000 species, to improve and restore habitat types with unfavourable conservation status.

Status: Ormož Basin Nature Reserve is managed and owned by DOPPS. Included in Natura 2000 area Drava and designated a Nature Reserve (Official Gazette of the Republic of Slovenia, no. 23, 5.5.2017, 3441-3445).

Lower Drava River - important ecological area (IEA) and a Natura 2000 site.

Areas: Woodland area, Wet area, Aquatic environment (rivers).

Action type: Creation of ecosystems/areas, Management, Restoration or rehabilitation (towards the ecosystems historical trend or repairing key functions).

Action framework: Climate change adaptation, Management of nature areas, Natura 2000, Spatial planning works.

History and context

The natural dynamics of the Drava River was heavily altered after the building of hydro-power plants at the project area – Natura 2000 area "Drava" (SI5000011 & SI3000220) between Maribor and Središče ob Dravi. Most of the water was diverted into the channels, while the prevailing discharges in the old riverbed were reduced drastically. Extensive network of river branches gradually diminished, the majority of them now remain unconnected to the main river and gravel bars are overgrowing. These changes caused the lack of suitable breeding/spawning habitat of several species. Sand Martin and Kingfisher are scarce as their requirements for large sand banks are not met. Alluvial forests (91E0*) were degraded and fish species like Bitterling, Asp, Spined Loach lost their habitats as well. Water-maintenance works on the Drava River intended to secure flood protection of humans and infrastructure, often lacked firm justification in the past and were destructive to biodiversity.

In 1977 the Sugar Factory in Ormož (TSO) was constructed and soon after its construction, the factory's wastewater basins began to host various waterbird species as breeders and migrants in significant numbers. An area of exceptional importance for birds at the national and wider scale was formed.

In 2006, due to sugar reform of the EU, TSO was closed. Immediately, DOPPS started activities for the conservation of the wetland and establishment of a nature reserve in the area of the basins.

Overview of sugar factory, its lagoons, lake Ptuj and Drava area (Source: DOPPS - BirdLife Slovenia)

Presentation of the project

Issues and objectives

Even though the natural dynamic of the Drava River was heavily altered after the construction of three hydro-power plants, some natural characteristics of this lowland river were still preserved. Due to large area of Drava River with its river branches, dry grasslands in the middle of a flooded forest, gravel bars, diverse river banks and other natural specificities with some artificial water bodies, such as accumulation lakes, are making this riparian ecosystem home to numerous (Natura 2000) species. Abandoned wastewater basins of Sugar Factory in Ormož (TSO d.d.) were restored as a semi-natural wetland with a constant supply of water which happened to be one of the key wetlands in Slovenia for a safe migration route of waterbirds.

Lagoon and sugar factory of Ormoz (Source: DOPPS - BirdLife Slovenia)

The project aimed to preserve and enlarge populations of species listed in Annex I of the Birds Directive (birds typical for lowland rivers) and Annex II of the Habitats Directive (fishes and beetles) by managing alluvial forest habitats (Annex I, Habitats Directive) along the Lower Drava River in Slovenia. The project also aimed to improve cooperation between the most important stakeholders along the river and to inform the public about the natural value of these Natura 2000 sites and the importance of their conservation. Specific objectives include:

- Transformation of 61 ha of former wastewater basins into a semi-natural wetland as a stopover site for migrating birds (Ormoz Basins);
- Habitat management of forest stands to improve the status of around 15 ha of alluvial forests;
- Establishment of a grazing system;
- Removal of illegally built fishing and hunting platforms to reduce hunting pressure;
- Creation of two new artificial breeding islands for Common Terns (total surface area 2100 m2);
- Opening up and restoration of three side arms of the Drava River (total length of 3.8 km);
- Preparation of the river banks to allow breeding by the kingfisher (Alcedo atthis) and sand martin (Riparia riparia);
- Management of gravel bars for Little Ringed Plover and Common Sandpiper (10 ha);
- A reduction of human disturbance at the gravel bars.

Human and material resources

DOPPS staff: 1 project manager, 1 financial manager, 2 education & public relations officers, 2 ornithologists, 1 warden, and 2 project assistants

VGB (Vodnogospodarski biro Maribor d.o.o; associated beneficiary) staff: 1 hydrology expert, 1 hydraulics and sediment transport expert, 1 GIS expert, 1 habitat expert, 5 designers, 2 environment experts, 1 coordinator

DRAVA (Vodnogospodarsko podjetje Ptuj, d.d. (associated beneficiary)); staff: 1 coordinator, 2 technicians, 1 responsible construction leader, 1 foreman, 5 semi- skilled workers

PTUJ (Urban Municipality of Ptuj (associated beneficiary)) staff: 1 coordinator

Material resources: Rubber boat with motor, small rubber boat, 5 binoculars, 2 telescopes, PC, car trailer for boat transportation, tractor with equipment, 1 motor schyte (brushcutter), 2 motor chains, software MIKE 21C, MIKE 11, MIKEFLOOD, equipment for ringing birds, grazing infrastructure – stable, electric fences, visitor infrastructure – observation tower, observation hides, parking, information boards

Animals: 10 water buffalos for grazing management in Ormož Basins Nature Reserve. Purchased from Neusiedler See – Seewinkel National Park in Austria after thorough analysis of conditions (water habitats, reed, neophytes) and grazing requirements. Turned to be right choice as we are able to create quality waterbird habitats through grazing management. Due to own reproduction since introduction, 16 animals are present at the moment at site.

Creation, restoration methods

Volunteers recreating the sandbank along the Drava - LiveDrava, SI. (Source: DOPPS - BirdLife Slovenia)

The project entails human intervention to restore ecological functioning, namely: grazing of wastewater basins, restoration of sand embankment, removal of illegal hunting and fishing platforms, reopening of side arms, removal of riprap, removing vegetation from overgrown gravel bars, creating new water inflow to the Ormož basins. For these last, engineers decided to project a pipeline with capacity max 240 L/sec instead of a ditch for the water inflow in Ormož Basins.

The project also entails land management, with the purchase and long-term lease (25 y) of the land. 6.9 ha of riparian flooded forest were purchased and a parcel of 6.,747 m2 leased..

Conservation management of the breeding islands at Lake Ptuj and preparation of river banks for breeding of Kingfisher and Sand Martin was done. Two 1000 m2 islands were built according to DOPPS instructions, hopefully permanently solving the demanding Common Tern conservation issue. To get even better insight into the breeding colony, a remote camera recording system was established on the breeding island that will serve for future monitoring. With the management the entire (100%) population of two Natura 2000 qualifying species at SPA Drava was possible – Common Tern and Sand Martin, and 25% of the Kingfisher population.

Habitat management in the softwood forest stands was carried out in Ormož Basins as well. Dead wood experiment was performed to improve habitat for endangered saproxylic beetle fauna. App. 40m3 of non-native hybrid poplars were logged at the Ormož Basins site. Dead trunks were left at two forest surfaces according to the project in such way that 30-40 and 10-20% increase of dead wood in the forest stands was created.

The problem of illegal hunting has been present at Lake Ormož for many years, causing significant reductions in wintering waterbirds, thus reducing the value of SPA Drava as well. A promotion campaign started, 2500

Ormoz Lagoons in progressive renaturation (Source: DOPPS - BirdLife Slovenia)

leaflets and 2000 posters were printed and distributed. A legal procedure to remove illegal objects at Lake Ormož started in Croatia, as well as field control. One particular case was reported to the police and lawbreaker was sent to trial. Lake Ormož is one of three sites where regular 10-day monitoring was carried out, registering bird populations and negative human impacts. Ormož Basins became state nature reserve and by governmental decree hunting in not allowed at the site.

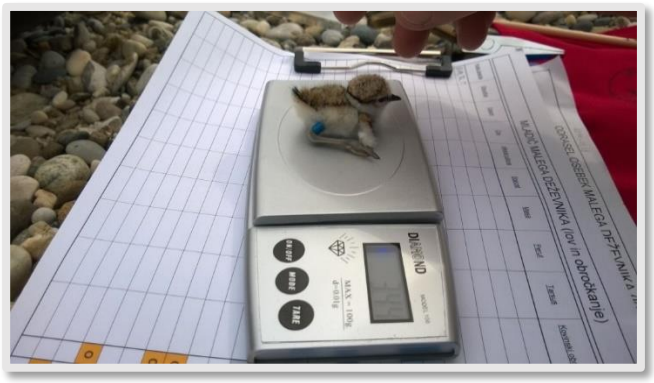
After more than a decade, the hamster (Cricetus cricetus) was again discovered in Sep 2014, in its only site in Slovenia within the proposed Nature park area, giving an additional nature-conservation argument to the Nature Park. Apart from the already mentioned creation of sand banks for Sand Martin and Kingfisher, three other concrete conservation actions are carried out in the river bed: To improve the habitat for Little Ringed Plover, 6 large overgrown gravel bars of total surface 10 ha were cleaned twice in an innovative way – action; 3 closed river branches were opened to improve the endangered target fish species priority habitat type and to enhance the foraging habitat of Kingfisher and Little Sandpiper; human disturbance at 7 gravel bars were reduced with placing of barriers or excavation of ditches.

Grazing management was established in Ormož Basins NR. Sub-contractor delivered a detailed grazing plan and according to this study the grazing system was established in the basins. 12,700m of fences were erected and a stable was built. Five water buffalos were released in the area in 2014 and additional 5 in 2016 and they turned out to be very effective, controlling vegetation even more than expected. Restoration works in the basins – new water supply was built and restoration of habitats carried out - habitats for breeding and migratory birds were created (5 large islands, 77 small islands, 1,753m of channels excavated).

Monitoring and evaluation methods

Complete monitoring was established in the very beginning for all target species, to be able to quantify the conservation effects.

Different types of bird indicators/specific monitoring were carried out in the project. Monitoring of waterbirds at Lake Ptuj and Lake Ormož was carried out by regular total counts during entire project period in 10-day intervals. Monitoring of all qualifying species for SPA Drava at Ormož Basins NR was carried out using mapping method annually between 2013-2017. Monitoring of the breeding numbers of Common Tern and Black-headed Gull was carried out during two visits (first in April - gulls, second in May - terns) in the managed breeding colonies every year. Monitoring of breeding riverbed birds was done using rubber boat without use of engine. Two to three counts were carried out every year in the riverbed of Drava River between Maribor and Zavrč. For this purpose entire section was divided into 3 sectors. Upon our request Slovenian Environment Agency (ARSO) issued us a permission (no. 35601-53/2013 – 4, dated 18th Apr 2013) for the performance of ecological study on Little Ringed Plover. In the study, capture-recapture, colour ringing and placing of geolocators was done. Field work was carried out between early April and early August in years 2014, 2015, 2016. In total, 177 nests were found (most in early stage of incubation or during egg-laying) and their fate followed in 4-day intervals until hatching or failure.



Characterized puppy small plover during weighing (Source: DOPPS - BirdLife Slovenia)

Beetle monitoring revealed that all together more than 170 beetle taxa were recorded in the area, among them 87 saproxylic. Besides Cucujus cinnaberinus, six additional important nature-conservation species were found in the dry part of the Ormož Basins Nature Reserve. One specie was recorded for the first time for Slovene beetle fauna - Acupalpus interstitialis.

After the abolition of illegal hunting at Lake Ormož, the populations of overwintering waterbirds significantly recovered. In the autumns and winters (Sep-Jan) of 2012/2013-2014/2015, only 2,300-4,300 waterbirds were recorded on the lake on average, whereas in the first season after the hunting abolition (2015/2016), this

number rose to 7 300 waterbirds, with the highest numbers in November even exceeding 10,000 individuals.

As a result of island's management, 118 pairs of Common Tern bred at Lake Ptuj in 2017, which is the largest number in the last 14 years. Black-headed Gull increased even more. In 2017 its population at SPA Drava was 853 breeding pairs – all at the Lake Ptuj on the managed island.

Bearded Tit (Panurus biarmicus), female & Common tern (Sterna Hirundo) (Source: DOPPS - BirdLife Slovenia)

Manual creation of breeding walls at the riverbanks significantly helped populations of Sand Martin and Kingfisher. With this management together with side arms restorations 5 new breeding pairs (BP) of Kingfisher was established which is increase of SPA population by 25%. Besides Kingfisher, Sand Martin benefited from the management, too. Efforts yielded an average of 574 BP of Sand Martins (in the 2013-2017 period), which is a threefold increase of the SPA population compared to the long-term average of 194 pairs in the 2000-2012 period.

Removal of woody vegetation from overgrown gravel bars resulted in an average 17 (35%) more breeding pairs of Little Ringed Plover and 6 (15%) of Common Sandpiper. Disturbances like illegal driving at the gravel bars were prevented at 7 sites. Ditches and road barriers were used and informative boards always placed to explain the meaning of the action. That way the disturbances were reduced for the first time ever on the SPA Drava and resulted in 4 (8%) new BP of Little Ringed Plover and 1 (2.5%) of Common Sandpiper.

In Ormož Basin Nature Reserve, during the spring migration, Wood Sandpiper and Ruff were again present after several years of non-appearance, indicating the area started functioning as the stopover site for shorebirds again. Breeding of Ferruginous duck, Garganey and Shoveler is expected in the future. Little Grebe, Marsh Harrier, Water Rail, Spotted Crake, Moorhen, Coot, Lapwing and Little Ringed Plover were already confirmed as breeders. White-tailed Eagle is regularly present at the area. Occurrence of all species is a direct result of the restoration. Water beetles were not directly targeted species for the basins, however monitoring revealed that the basins became the most important site for water beetles in Slovenia, holding at the moment largest number of endangered species! In restored river branch, species Graphoderus billineatus was not confirmed yet, but for the first time in the area the plant species Water Violet Hottonia palustris was found, which is promising for the beetle as it is ecologically connected to this plant species. Quantitative data for the saproxylic beetles cannot be evaluated yet, but both species Hermit beetle (Osmoderma eremita) and Cucujus cinnaberinus were found at the project area.

Fish monitoring revealed that the ecological conditions for the fish species improved after the carried out restoration of the three river branches. The Bitterling population became more stable and less vulnerable. The preservation of cut-off channels, side arms and deep sections of the Drava is crucial for the successful conservation of Bitterlings, Spined Loach and Asp. Sampling proved the presence of the majority of expected species, but for the first time at Drava River the Golden Spined Loach (Sabanejewia balcanica) was found. It is listed among Anex II species of Habitat Directive.

The results of the socio-economic study indicate an increase in the social acceptance of project activities, which confirms that communication and educational activities have had a positive effect in the adoption of NATURA 2000 area as an opportunity zone, and was not perceived as an obstacle. The results of all included target groups showed an increased awareness of the term Natura 2000 and an increased knowledge regarding the

protected areas. A socio-economic study made at the beginning and at the end of the project proved that the project significantly improved the public's knowledge of the Natura 2000 network, LIVEDRAVA project, Ormož Basins as an important bird area and DOPPS, as well as support to the Ormož Basins NR.

Description

Facilitation

As a Life project, reporting was to be done to the EC on a regular basis using prescribed approach and formats. 5 reports were prepared – one inception report, one midterm report, two progress reports and one final report.

The project also included a communication and education strategy towards schools and the public with lectures, field excursions and exhibitions, public events, but also documentary film, videoclips, brochures, booklets and articles in newspapers (see http://livedrava.ptice.si/).

Volunteers, especially faculty students, were included in many actions, like management of breeding islands for Common Tern, preparing breeding banks for Sand Martin and Kingfisher, management of Ormož Basins NR, events etc.

Partners

- Technical: water engineering company – VGB, water maintenance company – DRAVA, Urban municipality of Ptuj
- Scientific: DOPPS – Birdlife Slovenia
- Financial: European Commission, DEM – short name of Dravske elektrarne Maribor d.o.o., Municipality Ormož, MOP – Ministry of Environment and Spatial Planning

Costs and financing

The total budget was 4.098.910 € with EU contribution of 2.033.455 €. This includes 1,3 million for personnel, 1 million for assistance, 1 million for infrastructure, 270.000 for equipment, 91.000 for consumables.

Work on the river bank and aerial photos before and after restoration (Source: LiveDrava layman's report, 2018)

Timetable

ACTION TIMETABLE

2012 (Sep-Dec) & 2013	2014	2015	2016	2017
Technical blue-prints for restoration works (ecological engineering measures) Technical blue-prints for the Ormož Basins Nature Reserve visitor facilities Guidelines for sustainable water management of the Drava for the national Danube River basin management plan for the period from 2016-21 Geodetic survey and marking out the land (demarcation) Purchase of flooded forest fragment Conservation management of the breeding islands at Lake Ptuj Web site of the project Setting up the basic facilities in Ormož Basins Nature Reserve (the temporary project office) Management of gravel bars for the breeding of the Little Ringed Plover	Hydraulic analysis – flood and sediment transport modelling Habitat management in the softwood forest stands in Ormož Basins Nature Reserve Removal of illegally built fishing and hunting platforms at Lake Ormož Restoration of the river branches Preparation of the river banks for breeding of Kingfisher and Sand Martin Impact of project actions on bird species Impact of project actions on beetle species Setting-up the basic visitor facilities at Lake Ptuj Study of the socio-economic impact of the project actions Production and distribution of project publications Project educational program Public presentations and excursions Networking with other projects	Restoration of Ormož Basins & river branches & reduction of human disturbance Hydraulic analysis – flood and sediment transport modelling Technical blue-prints for the Ormož Basins Nature Reserve visitor facilities Management plan, restoration of the habitats for waterbirds & detailed grazing plan for Ormož Basins Nature Reserve - Guidelines for sustainable water management of Drava River for the national Danube River basin management plan for period 2016-2021 Lease of a single parcel to reach the integrity of the restored area Construction of water supply and regulation system & establishment of the grazing system for long-term wetland management in Ormož Basins Nature Reserve Creation of new artificial breeding island for Common Terns at Lake Ptuj & conservation management Preparation of the river banks for breeding of Kingfisher and Sand Martin	Management plan for Ormož Basins Nature Reserve & Establishment of a grazing system for long-term and sustainable wetland management Guidelines for sustainable water management of Drava River for the national Danube River basin management plan for period 2016-2021 Conservation management of the breeding islands at Lake Ptuj Declaration of Ormož Basins Nature Reserve and Nature park at the Drava River between Ormož and Središče ob Dravi Restoration of the river branches Preparation of the river banks for breeding of Kingfisher and Sand Martin & reduction of human disturbance Impact of project actions on bird & fish species Production and distribution of a documentary film of project publications Networking with other projects Project educational programme	Declaration of Ormož Basins Nature Reserve. Evaluation of the habitat and species monitoring results (ecosystem approach) Layman's report Production and distribution of project publications Audit After-LIFE Conservation Plan

Project was completed: 31/12/2017

Overall assessment

Riparian ecosystem of the Drava River has been degraded in the past, with populations of riparian ecosystem and qualifying Natura 2000 species either decreasing or disappearing. DOPPS have been active in the area ever since the establishment in 1979. Several threats or larger problems contributing to the degradation have been recognized and placed at the centre of our nature conservation actions within the project. During the implementation of the project we attempted to demonstrate the importance of ecosystem services provided to mankind free of charge, too. Project LIVEDRAVA is finished but nature conservation and striving for public welfare along Drava River continue.

STRONG POINTS

- Successful partnership between research organisation and private companies
- Consideration of local context
- Use of local wild plant species (genetic diversity, adaptability to local conditions…)
- The ephemeral wet areas amongst open flower-rich habitat that was trialed at roof level represented many of the habitat features that are typically associated with marshland areas of brownfield sites (e.g. wetland plant species, pollen and nectar sources, ephemeral wet areas) Success in restoration of endangered species
- Wide network of volunteers - volunteers were engaged in several project activities and can be counted on for the recurring management activities
- Achieved policy uptake of sustainable water management into the legislation
- Strengthen cooperation and communication between most important stake-holders in the project area.
- Communication and educational activities have had a positive effect in the perception of NATURA 2000 and nature conservation in the public

WEAK POINTS

- Unfortunately, despite all the efforts, formal Nature Park declaration was not reached
- Network of volunteers is listed under strong points but it should be pointed out too that it might happen that in the future with rising demands for volunteer work the "supply will not reach the demand".
- Traditionally, inspection service in Slovenia do not work, especially when laws regarding nature are violated. This is a weak point if we would like to continue reducing disturbances at gravel bars as violations must be sanctioned to achieve the effect. E.g. an illegal moto-cross polygon appeared in one of our project sites in Natura 2000. The case was reported to the inspection service, but as expected, without any effect.

IMPROVEMENTS - ADVISES

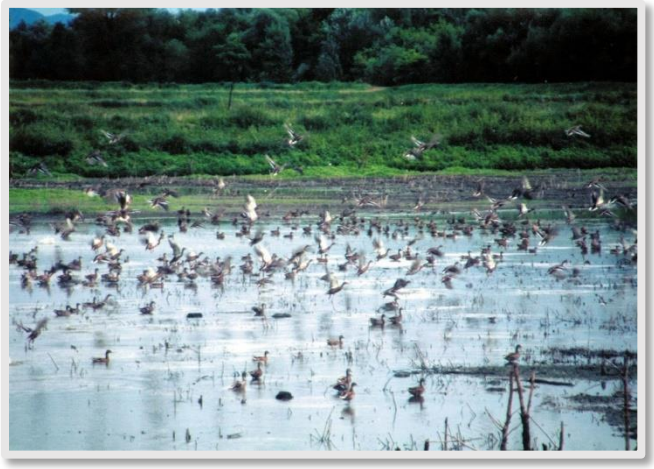
- The largest risk for the project came from inside. One of the partners, Institute of the Republic of Slovenia for Nature Conservation, left the project in the beginning as their expectations and conditions were not met, therefore caused troubles to the project. However, the rest of the partnership remained stable and secured all the actions. Advice would be to select project partners in advance very carefully.

Perspectives

Continuation

Eight projects were so far applied or prepared directly following LIVEDRAVA activities, 5 were confirmed, 1 rejected, 2 are in evaluation procedure.

Among confirmed projects is Interreg Slovenia-Croatia project "ČIGRA" (Čigra meaning in Slovene and Croatian "Tern") that started in Sep 2017 and will end in Feb 2020 (http://ptice.si/cigra-2017-2020/). LIFE results – guidelines for Tern management – were of significant importance



Lagoon as a rest area for birds (Source: DOPPS - BirdLife Slovenia)

during the project preparation as LIFE experiences of Tern conservation will be transferred to Croatian colleagues within the ČIGRA project. Besides knowledge transfer and Common Tern database, DOPPS will continue conservation management of the islands, promote Tern's conservation through international education camp with young, organize Tern "open-days", place additional education boards at Lake Ptuj, publish magazine dedicated to Common Tern, continue and extend research within the ČIGRA project. So in the next 3 years of after-LIFE period we will even intensify our work on Common Tern including conservation, research, promotion/education and capacity building aspects.

DOPPS is registered as agriculture holding (KMG ID 100325669) and successfully applied "Ecological farming" measures. Parcels in the Ormož Basins NR are included in the measure (http://rkg.gov.si/GERK/WebViewer/, GERK ID 5466544), as we carry out conservation management with grazing. Annual subsidy is expected.

The Nature Reserve has been declared and governmental decree adopted. The decree defines that the Ministry should hire "caretaker" of the site who should prepare management plan, control the regime, and implement conservation management. Payment of the service is foreseen. DOPPS – BirdLife Slovenia, the legal owner of the site with extensive references in conservation management, signed the contract with the Ministry as the caretaker. This way the basic funding for the functioning of the reserve is secured in the after-LIFE period.

Transposability

Many such areas exist along most of EU rivers and could deserve similar management approach to increase local diversity, especially of endangered species.

Guidelines for sustainable water management of Drava River were presented and available to relevant expert audience, and we strongly believe they will serve as model for similar initiatives in Slovenia and throughout the EU. Therefore, we argue that strong added value of the entire project is corroborated through high replication potential of these Guidelines and their orientation towards the implementation of EU policies. Achievement of policy uptake were presented in details at the LIFE conference in Zagreb on 2nd Feb 2018 organized by Ministry of Environment and energy of Croatia under LIFE14 CAP/HR/14 project.

Publications

- Project Reports: Progress Report (2015), Midterm Report (2014), Inception Report (2013)
- Layman's report, http://livedrava.ptice.si/wp-content/uploads/2018/01/2018_12_1_LIVEDRAVA_Laymans_report_web_v2.pdf
- Ormož Basin Nature Reserve (Guide), http://livedrava.ptice.si/wp-content/uploads/2017/06/2017_16_6_UradnilistRS_023_2017_NROL.pdf
- Naravni rezervat Ormoške lagune (Guide), http://livedrava.ptice.si/wp-content/uploads/2014/09/2017_9_11_NROL_vodnik_2017_ANG_splet.pdf
- Drava River – Nature's Gift for Every Generation, http://livedrava.ptice.si/wp-content/uploads/2014/09/Drava_brosura_22x18_web.pdf
- Naturschutzgebiet Ormoške lagune

Cleaning a pebble island (Source: DOPPS - BirdLife Slovenia)

Sand martin nests on a created sand shore (Source: DOPPS - BirdLife Slovenia)

Realized by:

With the financial support of:

AGENCE FRANÇAISE
POUR LA BIODIVERSITÉ
ÉTABLISSEMENT PUBLIC DE L'ÉTAT

and the technical support of the French Ecological Engineering Resource Centre:

Centre de ressources
GÉNIE ÉCOLOGIQUE

Barking Riverside Green Roof Ecomimicry Experiment

N°4

IN A NUTSHELL

Identity of the organisation

Organisation: University of East London Sustainability Research Institute and Barking Riverside Ltd.

Website: www.turas-cities.eu/case_study/10

Contact: Stuart Connop, Senior Research Fellow at UEL, email: s.p.connop@uel.ac.uk, Tel: 02082234985

Site identity

Site: Barking Riverside

Location: Barking Riverside, London Borough of Barking & Dagenham, UK

Specificities: Post-industrial brownfield site that supported important biodiversity now being redeveloped to provide 11,000 homes

Challenges: Conserving important brownfield invertebrate community of regional importance as part of strategic multifunctional green infrastructure. Target species included the brown-banded carder bee (*Bombus humilis*) (UK Biodiversity Action Plan Priority Species) and *Gymnosoma nitens* (RDB1) but also a wider set of species.

Status: Open Mosaic Habitat is a Habitat of Principal Importance for Biodiversity in England

Areas: Open area, Wet area, Urban area, Other artificial environment - post-industrial brownfield habitat mosaic.

Action type: Creation of ecosystems/areas, Reallocation (for another use).

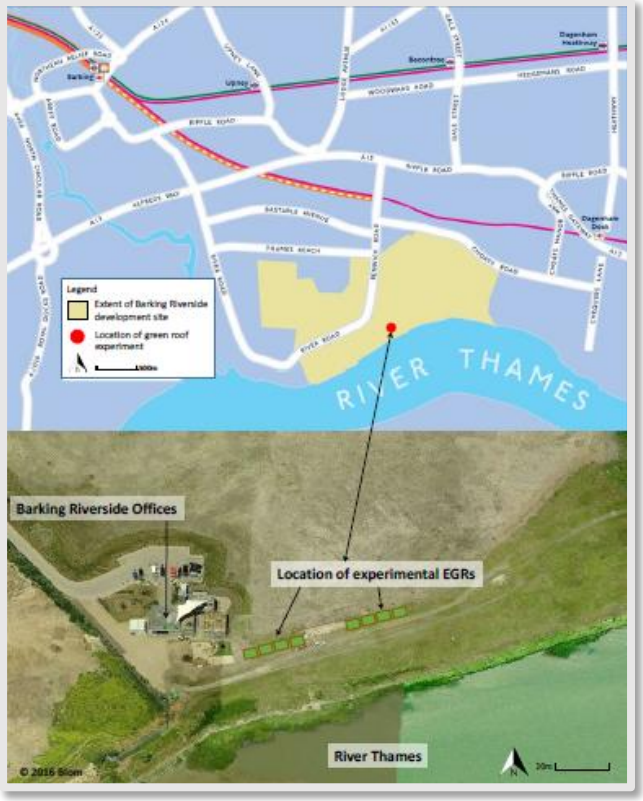
Action framework: Climate change adaptation, Land planning, Biodiversity conservation, Stepping stone connectivity.

History and context

This project used an innovative ecomimicry approach to designing urban green infrastructure for the new development. Ecomimicry involves mimicking the characteristics of local ecosystems, in this case regionally important open mosaic habitat which had formed on the post-industrial brownfield site.

Designing green roofs using ecomimicry of key brownfield habitat niches provided a mechanism for conserving the biodiversity, habitat connectivity and ecosystem service provision of the brownfield site post-development. This approach also offered opportunities for local communities to reconnect with nature, and the industrial heritage of the site, promoting engagement, ownership and enjoyment.

Novel green roof designs were developed and tested on site and were successful in supporting the regionally important biodiversity associated with the site prior to development. The results are being fed into innovative green infrastructure design that will be rolled out more broadly across the site as wider redevelopment continues. Embedding regional context into green roof design enabled alleviation of location-specific issues caused by urbanisation of the site and allowed restoration of regionally typical and important habitat and ecosystems. It is hoped that such design will enable Barking Riverside site to act as stepping stone habitat (Saura et al., 2014), providing connectivity between key sites that are being conserved and protected in the region



Location of the ephemeral green roof experiment at Barking Riverside, London, UK. Image taken from Nash (2017). Plan of Barking Riverside development site in upper half of figure - ©Transport for London. Aerial image © Blom, Bing maps, 2016.

Presentation of the project

Issues and objective

Bordering the River Thames, historically the Barking Riverside site was tidal grazing marsh. The site was later drained and Barking Power Station was developed.

Following the closing down of the power station in the 1980s, the site was largely abandoned leaving the areas where pulverised fuel ash was widely deposited to develop the typical post-industrial characteristics of unmanaged and sparsely vegetated greenspace. In this state, the site supported a suite of ecosystems services and regionally important biodiversity. In 2007, outline planning permission was granted to build a new community on the site including approximately 11,000 homes, schools and transport infrastructure. The planning process recognised the value of the pre-development (pre-construction) brownfield site in terms of supporting biodiversity of significant value, in particular a regionally important invertebrate assemblage, as well as providing ecosystem services such as pluvial and fluvial stormwater management and greenspace for health and wellbeing. Such Open Mosaic Habitat is a habitat of principal importance for conservation under Section 41 of the Natural Environment and Rural Communities Act. It is habitat type that can be found on post-industrial sites following abandonment when recolonisation occurs on low-nutrient/contaminated substrates.

The slow recolonisation, combined with lack of regular management intervention, can enable nationally important assemblages to develop, particularly rare invertebrate assemblages. The mosaic can include a range of early successional habitat types (e.g. annuals, mosses/liverworts, lichens, ruderals, inundation species, open grassland, flower-rich grassland, heathland) alongside other more mature habitat types (e.g. scrub and secondary woodland with varied hydrology). This habitat has become a proxy habitat for many species associated with natural and semi-natural early successional habitat types that have been lost in the broader landscape to costal management, agricultural intensification, urbanisation, etc (e.g. heathland, wildflower-rich open grassland, soft rock cliffs, littoral zones). A range of conservation target species in the pre-development brownfield area are found like water vole (*Arvicola amphibius*), grass snake (*Natrix natrix*), black redstart (*Phoenicurus ochruros*) and marsh warbler (*Acrocephalus palustris*) along with a broad invertebrate assemblage of regional importance (including the brown-banded carder bee (*Bombus humilis*) (UK Biodiversity Action Plan Priority Species) and *Gymnosoma nitens* (RDB1) and a number of nationally rare and scarce species).

Wooden frames constructed as a base for the ephemeral wetland green roof experiment - Barking Riverside, London, UK. (©UEL SRI)

Planning consent included a requirement to conserve this biodiversity and ecosystem service value on the site post-development as part of the vision for a sustainable new community. Included in the planning conditions was the requirement for 40% of properties to have green roofs to ensure the site could continue to support key species assemblages and provide multifunctional ecosystem services. This 40% target was determined by the Local Authority during the outline planning permission

application process, building on the Mayor of London guidance recommending green roofs on major developments. A key step in relation to this condition was to ensure that the designs for the green roofs on the development were multifunctional and based on regional context, both in terms of being climate-resilient and relevant to regional biodiversity of national and international conservation importance. A Knowledge Transfer Partnership was set up between the developer, local authority and local university to investigate best practice for green roof design to achieve these aims. This partnership later became part of the EU FP7 programme TURAS (Transitioning towards Urban Resilience and Sustainability) within which an experiment was established to investigate the potential for incorporating ecomimicry of locally typical and important habitats associated with the pre-development brownfield habitat mosaics present on the site into the design of the green roofs. During a scoping process, it was identified that ephemeral wetland habitats were a key microhabitat associated with the brownfield mosaic that were not being incorporated into typical green roof design in the region. As a result of this, an experiment was established to investigate whether ephemeral wetland habitat could be recreated as part of green roof design and whether this would add to the habitat heterogeneity of the roofs providing a greater diversity of niches to support biodiversity. The overall aim being to maximise the value of the green roofs in terms of providing compensatory habitat for the loss of high environmental value brownfield land.

Freight containers with ephemeral wetland green roofs on top in place for experimental monitoring - Barking Riverside, London, UK. (©UEL SRI)

The roof design took inspiration from the Open Mosaic Habitat found on the Barking Riverside site prior to development. Part of the project involved analysing invertebrate assemblages associated with post-industrial sites like the one at Barking Riverside. Key assemblages and their habitat associations were identified at these sites. An analysis was then carried out to identify which of those assemblages were already being supported by standard extensive biodiverse green roof designs. Those assemblages that were not typically recorded on green roofs were then assessed to identify which could potentially be supported by green roofs if the roof design were manipulated to provide a greater range of habitats. It was these habitat associations that were targeted for mitigation (re-creation).

Human and material resources

Nine used 20 foot freight containers were purchased as the base for the experiment. The frames for the green roof test beds were constructed out of timber. Freight containers were used as a practical solution in the absence of suitable built structures. Whilst these provided only a single storey level, their position on site, close to the river corridor, meant that they were very exposed and, thus, environmental conditions on the roof would have been similar to those experienced at higher roof levels in other locations. As such, habitat development would be expected to be typical of building roof conditions. Previous studies have demonstrated that height of roof may lead to limitation for accessibility for some groups/species. However, this is a gradated response in relation to height and species/groups, so further experimentation would be required to investigate any effect in relation to colonisation of ephemeral wetland roofs.

In terms of thermal insulation, most modern buildings have such efficient insulation that it would not be expected to impact on a green roof above. Due to the wooden construction of the green roofs, which left a space between the container and the green roof, a similar lack of direct influence would have been expected in terms of the thermal dynamics of the freight container impacting roof development. Nevertheless, roof trials would be the only way to confirm the replicability of results in other situations.

Each green roof platform was approximately 6 x 3 m and also included a waterproof membrane, geotextile filter fabric, substrate and seeds/plug plants. Edge protection was also needed because the experiment was on a live construction site and was to be regularly monitored. All materials used were standard green roof construction materials. All plant plugs and seeds were obtained by a local supplier with local provenance.

Freight containers with ephemeral wetlands green roofs with substrate installed. Barking Riverside, London, UK. (©UEL SRI)

Construction of the experiment involved:

— 2 construction workers from the Barking Riverside site 2 days to prep the ground for the experiment (levelling) and moving the freight containers into position,

— Approximately 4 days training from 2 specialist green roof construction workers from the Grass Roof company, followed by 4 workers (staff members and PhD student from UEL) working for approximately 14 days to build the green roof platforms and install the waterproofing, substrate and plants.

Monitoring was undertaken by a PhD student at UEL for two growing seasons.

Creation, restoration methods

The test platforms were built according to small green roof construction best practice and following principles for biodiverse green roof design (e.g. using varied substrate types and depths and planting with native species). The roofs were seeded with a combination of three 100% wildflower seed mixes supplied by Emorsgate Seeds (www.wildseed.co.uk) as follows: EM8F wildflowers for wetlands; EN1F special pollen and nectar wildflowers; ER1F wildflowers for green roofs. This mix was then broadcast at a rate of 2 g/m2.

Toits verts à zone humide éphémère une fois les plantes installées, Barking Riverside, London, UK. (©UEL SRI)

Seeded species comprised: *Achillea millefolium, Agrimonia eupatoria, Anthyllis vulneraria, Betonica officinalis, Centaurea nigra, Centaurea scabiosa, Clinopodium vulgare, Daucus carota, Echium vulgare, Eupatorium cannabinum, Filipendula ulmaria, Galium verum, Hypericum perforatum, Iberis amara, Knautia*

arvensis, Leontodon hispidus, Leucanthemum vulgare, Linaria vulgaris, Lotus corniculatus, Lotus pedunculatus, Malva moschata, Onobrychis viciifolia, Origanum vulgare, Plantago lanceolata, Plantago media, Poterium sanguisorba, Primula veris, Prunella vulgaris, Ranunculus acris, Reseda lutea, Rhinanthus minor, Rumex acetosa, Salvia verbenaca, Sanguisorba officinalis, Scabiosa columbaria, Silaum silaus, Silene dioica, Silene flos-cuculi, Silene vulgaris, Trifolium pratense, Verbascum nigrum, Vicia cracca.

Wetland species plugs were planted at a density of 5 plugs per square metre. These species comprised: Achillea ptarmica, Carex dioica, Juncus effusus, Lythrum salicaria, Ranunculus flammula, Myosotis scorpioides.

The ecomimicry approach involved designing novel drainage treatments for the roofs to recreate an ephemeral wetland habitat niche - a specialised habitat of value to rare and scarce invertebrates that inhabit regionally important brownfield sites. The ecomimicry design involved the use of two substrates:

— A standard recycled brick extensive green roof substrate from Shire Green Roof Substrates Ltd (http://www.greenroofsubstrates.co.uk/).

— A novel aggregate made from recycled pulverized fuel ash (PFA) called Lytag (http://www.lytag.com/), mixed with 10% by volume green waste compost (PFA was present on the brownfield site and had contributed to its biodiversity value, therefore this substrate was designed to mimic the ground level substrate found on site pre-development).

The roof design should impose no additional constraints for the architect. The roof held no more water than a standard green roof, it merely held the water within the substrate and pools rather than within a standard drainage layer. As such, the roof would be expected to be heavier for longer periods of time than a standard extensive green roof, but the maximum loading (for which structural loading is calculated for a green roof) should be no different.

Similarly, construction costs would be similar to a standard extensive biodiverse green roof. As there was no cost associated with a drainage layer (often the most expensive part of green roof design), the cost may actually be less.

The only technical issue for architects would be related to having standing water sitting directly on the waterproofing membrane for sustained periods of time. This could, however, be avoided by manipulating the design so that water was pooled in a separate layer above a drainage layer/waterproofing membrane. Thus, if the pooling layer failed, the roof would then perform as a standard free draining green roof system. Planting was based on native species of known value on brownfield sites in the region and included a range from dry to wetland species.

Two plant species on the green roofs.. Barking Riverside, London, UK. (©UEL SRI)

Monitoring and evaluation methods

The experimental roofs were monitored for two growing seasons in 2014 and 2015. Monitoring comprised botanical surveys using a 50 x 50 cm quadrat to record species frequency and abundance and line transects to monitor plant structural development, as well as invertebrate surveys using a standard pitfall trap methodology. Each method was repeated across key habitat features on each roof, and surveys were conducted 4 times throughout each survey period to coincide with early, mid and late summer. Surveys recorded plant development (diversity and structure) and invertebrate community composition in relation to key design features (novel drainage treatment, and substrate depth and type).

The design was successful in producing a novel ephemeral wetland habitat on the green roofs and the overall design enabled a habitat mosaic of tall and short herbs, bare ground and seasonally wet areas to develop. In total 114 plant species were recorded during 2014 and 2015, comprising 36 of the planted species, and 78 species which had spontaneously colonised the roofs. Many colonising plant species were characteristic of high quality brownfield sites. Plant development was significantly different on the two substrates and cover and richness was higher on mounds.

The invertebrate community recorded on the roofs demonstrated that many of the species characteristic of the pre-development brownfield site had colonised the roofs, including a relatively high number of nationally rare and scarce species. A total of 53 species were identified from pitfall trap samples across all roofs for the target Orders Araneae, Coleoptera and Hymenoptera. This included *Scybalicus oblongiusculus* (RDB1+extinct), *Bombus humilis* (UKBAP species) and *Lasioglossum pauperatum* (RDB3). In terms of enhancing the mitigation value of biodiverse green roofs, results of the monitoring indicated that adopting an ecomimicry design principle was an effective way to provide more locally-attuned green infrastructure solutions.

SRI researcher, Dr Caroline Nash, carrying out vegetation quadrat surveys on the experimental ephemeral wetland green roofs - Barking Riverside, London, UK. (©UEL SRI)

Description

Facilitation

For the developer, impetus for involvement in this project came from planning conditions in relation to biodiversity and SuDS combined with an overarching aim to create a sustainable development pushed by the public-private partnership of the Greater London Authority working with a private housing developer.

Funding and technical expertise/knowledge exchange to realise the project was provided to the developer via the TURAS EU FP7 project which included a research and innovation work package investigating state-of-the-art

technology and processes to maximise the biodiversity and economic value of urban green infrastructure. Reporting was delivered at two levels. Firstly to the developer in terms of implications for the design of the development as a whole. Secondly to the European Commission that funded the research.

Partners

— Technical: Grass roof company (GI specialists - delivery), Green Infrastructure Consultancy (GI specialists -design), Hertalan UK (roof membrane expertise), Shire Aggregates Ltd (green roof substrate manufacturers).

— Scientific: University of East London Sustainability Research Institute

— Financial: Barking Riverside Ltd, the European Commission's DG Research and Innovation, University of East London.

Costs and financing

The approximate cost for establishing the experimental units (9 shipping containers, each with a 6 x 3 m green roof on top) was approximately €45,000. Cost for the PhD studentship was approximately €70,000 for the three year period.

Timetable

ACTION TIMETABLE

April 2014	May to October 2014	May to October 2015	Dec 2015	Nov 2017
Green roof construction completed	Green roof monitoring	Green roof monitoring	Green roof design guidance document produced	Ecomimicry PhD completion

Construction was completed in April 2014, and a two year biodiversity monitoring programme finished in October 2015.

Overall assessment

— It was possible to read the landscape and embed this into the design of green infrastructure at the site to make it locally contextualised and valuable to target biodiversity.

— Adding habitat variability created more niches for biodiversity and habitat suitable for local conservation priority biodiversity.

— Habitat provision was suitable for supporting at least some of the lifecycle requirements for a range of target conservation priority invertebrate species.

— Lots of interesting results in terms of niche partitioning, flora, invertebrate species and assemblages (including a high proportion of rare and scarce species), and birds - many of which were also associated with the pre-development brownfield state of the site

— Additional structural loading requirements for the green roof from such an approach were avoided.

— Industry standardisation of green infrastructure (e.g. green roofs) can be avoided through collaborative processes that bring local context, ecological expertise and design expertise together in projects.

— It is possible to expand the range of habitats provided by standard urban landscape design by incorporating expert ecological understanding into the design.

— Academic-industry case studies are an excellent tool for streamlining and maximising the benefits of the green infrastructure design processes.

— Green roof aggregates can be designed to mimic substrates found on the ground in the pre-development state of post-industrial sites.

— Whilst the case study was locally targeted, the principles of what were done were globally applicable.

— The broader ecosystem service functions of green roofs should not be impacted by the change in design (e.g. no obvious trade-off).

— There is often more potential for creating ecologically functioning systems and incorporating habitat heterogeneity at roof level than at ground level in cities (due to less pressure for aesthetics at roof level).

— Co-creational approaches enable better understanding between partners and better pathways to impact for academics.

The project was mitigation for what was being lost at the time of the development. The invertebrate assemblages associated with this open mosaic habitat were a key factor in the importance of the site for biodiversity and need for mitigation.

Ephemeral wetland green roof experiment after a summer rain event. Image shows the effect of manipulating the hydrological dynamics of the roofs with water pooling on the green roof in the foreground and no pooling present in the roof in the background - Barking Riverside, London, UK. (©UEL SRI)

STRONG POINTS	WEAK POINTS
— Successful partnership between research organisation and private companies — Consideration of local context — Use of local wild plant species (genetic diversity, adaptability to local conditions…) — The ephemeral wet areas amongst open flower-rich habitat that was trialed at roof level represented many of the habitat features that are typically associated with marshland areas of brownfield sites (e.g. wetland plant species, pollen and nectar sources, ephemeral wet areas)	— Short term assessment (two growing seasons) of the biodiversity transfer on green roofs (sustainability over long term?) — No specific assessment of transferability to real green roof — …There may be a reluctance for architects to put standing water on roofs. However, it is possible to adapt design so that pooling is never directly on the water proofing membrane. — There may be concern regarding the trade-off in terms of increased risk of mosquitos. However, the roofs are designed to be ephemerally wet, rather than permanently. During the summer (the time with greatest risk of mosquito development) the roofs typically only pooled water for 24 hours following a rain event. This is generally not long enough for mosquitos to complete their development cycle. The roofs would be expected to pool for longer periods during the winter months, but this is not currently an issue for mosquitos due to the cold climate in the UK during the winter months.

IMPROVEMENTS - ADVISES

— Allow more cost and time than you would envisage at the start of the project.

— Creating sufficient replication to enable large-scale controlled experimentation.is one of the biggest challenges for urban ecology.

— Co-creational process require buy-in from all partners and independent facilitation can help all partners understand each other's aims and objectives for involvement.

— Reading the landscape is the critical first step in such ecomimicry design. Both in terms of understanding the natural features and ecosystems and in terms of understanding the ecosystem service needs of a location.

Perspectives

Continuation

The project has been relocated to the university campus where it will continue to be monitored for its biodiversity value. The university's Docklands Campus is in close proximity to the development. As such, open mosaic habitat is a key habitat in the new location also.

Monitoring will be used to create an inventory of species and change over time. The ephemeral wetland green roof and ecomimicry green roof concepts are already being embedded within London and more broadly. This included embedding design and process guidance (Connop and Nash 2016) into the Phase 2 green infrastructure masterplan for the new development at Barking Riverside.

Transposability

The exact designs used in this case study were locally contextualised and therefore are not appropriate for all locations. However, the process of feeding ecomimicry into the design of urban green infrastructure to make it locally contextualised and adapted for locally important biodiversity is universally applicable. All too often, biodiversity is an assumed benefit of urban green infrastructure with a singular or narrow purpose (e.g. SuDS, amenity space, grass verges or allotments).

However, if urban areas are to fulfil their potential in terms of providing habitats for biodiversity and opportunities for urban communities to experience nature on their doorsteps, design for biodiversity needs to be a key consideration in the development process. This project shows how academia-industry partnerships and learning-by-doing processes can help to support such targeted biodiversity-driven design.

Ephemeral wetland green roof during summer rain event - University of East London Docklands Campus, London, UK. (©UEL SRI)

Publications

— Nash, C. (2017) Brownfield-inspired green infrastructure: a new approach to urban biodiversity conservation. PhD thesis submitted to the University of East London, UK.

— Connop, S. and Nash, C. (2016) Ecomimicry for Barking Riverside: Achieving locally contextualised biodiversity-led multifunctional urban green infrastructure. TURAS report: University of East London.

— Connop, S., Vandergert, P., Eisenberg, B., Collier, M., Nash, C., Clough, J. and Newport, D. (2016) Renaturing cities using a regionally-focused biodiversity-led multifunctional benefits approach to urban green infrastructure. Environmental Science & Policy 62, Pages 99–111.

— Connop, S. and Nash, C. (2014) TURAS Milestone 8 - Barking Riverside Green Roof Experiment: Phase 2. London. Report produced for the EU FP7 project TURAS (Transitioning towards Urban Resilience and Sustainability) project by the University of East London, London, UK.

Other text references:

— Saura, S., Bodin, Ö., & Fortin, M.J. (2014). Stepping stones are crucial for species' long-distance dispersal and range expansion through habitat networks. Journal of Applied Ecology 51, 171-182.

Realized by: International Office for Water

With the financial support of: AGENCE FRANÇAISE POUR LA BIODIVERSITÉ ÉTABLISSEMENT PUBLIC DE L'ÉTAT

and the technical support of the French Ecological Engineering Resource Centre: Centre de ressources GÉNIE ÉCOLOGIQUE

Forest Life project - Restoration of boreal forests and forest-covered mires LIFE03NAT/FIN/00034

N°5

IN A NUTSHELL

Identity of the organisation

Organisation: Metsähallitus

Website: http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=2485

Contact: JUSSI PÄIVINEN, Director, Development Projects, Jussi.Paivinen@metsa.fi, +358 (0)40 866 9346; +358 (0)206 39 5068

Site identity

Location: 33 "Natura 2000" sites in Finland (see the map).

Specificities: A lot of boreal forests, mires and esker forests in Finland have been modified by commercial operations and human activities. Their surface is progressively shrinking, biodiversity is decreasing and their structure and functions are altered.

Challenges: Boreal forests, eskers forests and bog woodlands are important refuges for a wide range of species and especially birds, who use these forests for breeding or during migration. Some targeted habitats are priority habitats under the European Habitats Directive, such as Western Taïga (9010) and Bog Woodland (91D0).

Many species of polypores, insects and mosses depend on dead wood and are today threatened due to the lack of decaying wood.

Areas: Woodland area, wet area

Action type: Restoration or rehabilitation

Action framework: Management of nature areas, Natura 2000

History and context

Only about a quarter of the forests inside protected areas in southern Finland are in their natural state or a close-to-natural state (Similä and Junninen, 2012). Most of these forests have been commercially managed at some time in the past, before they were designated for protection[1]. The main threats to natural heathland forests and their characteristic species are insufficient quantities of decaying wood, unfavourable changes in the age-structure and tree species assemblages of forests, the scarcity of natural forest fires, eutrophication and the fragmentation of forest habitats.

Forest ecosystems have been managed for decades to promote biodiversity in Finland's protected areas, but the extensive restoration of heathland forest habitats was initiated only in 2003 through related EU LIFE projects and the METSO Forest Biodiversity Programme for Southern Finland.

Occasional wildfires are typical of boreal coniferous forests and therefore a lot of the species have in the course of time also adapted to making use of trees killed by fires. Since wildfires can today be effectively suppressed, species depending on them are becoming threatened, due to the lack of decaying wood (such as tens of beetle species (e.g. *Boros schneideri, Pytho kolwensis, Tragosoma depsarium*, etc.), tens of polypore species and many hole-nesting birds (e.g. *Parus sp, Glaucidium passerinum, Aegolius funereus*, etc.)[2].

Forests growing on eskers are sunny and dry. Wildfires used to be frequent in Finnish esker forests. Since wildfires are today effectively suppressed and since a lot of the esker forests have been turned into commercial forests, sunny habitats have decreased. This has had a detrimental effect on plants, such as the Breckland Thyme (*Thymus serpyllum*), that require such habitats. In turn, insects have also suffered, including *Apion atomarium* (a seed weevil) and *Merrifieldia leucodactylia* (a moth) that use the Breckland Thyme as their host plant.

Mires used for commercial forestry often contain drainage ditches. Natural forest-covered mires have become scarce, especially in southern and western Finland. Forest-covered mires, especially spruce dominated mires, however provide a habitat for a number of bird, insect and cryptogam species.

Moreover, forests are fragmented by networks of logging roads. When forests are turned into conservation areas, unused roads that are no longer needed for logging can be removed and thus unnecessary motor traffic in conservation areas can be reduced.

Tragosoma depsarium, *an example of threatened saproxylic beetle species. © P.MARTIKAINEN*

[1] In Finland, Natura 2000 areas were selected around 1995-1997. Most of them are strictly protected (commercial forestry not allowed). That means all negative changes in state of habitats have happened before 1997. In general, forestry became intensive after the Second World War. In addition to Natura 2000 areas, there is a vast amount of other strictly protected areas (no commercial forestry allowed). In Finland, nature conservation is a continuously ongoing process: new areas of forests and peatlands are strictly protected each year.

[2] The list of all threatened species and the causes of threats in Finland can be found at : http://www.ym.fi/fi-FI/Ajankohtaista/Julkaisut/Erillisjulkaisut/Suomen_lajien_uhanalaisuus__Punainen_kir(4709) and updated Red List of Finnish Bird species at https://helda.helsinki.fi/bitstream/handle/10138/159435/Suomen_lintujen_uhanalaisuus_2015.pdf?sequence=1

Presentation of the project

Issues and objectives

Because of the pressures above-listed, the aim of the Forest Life project was to restore forests and mires, in order to maintain and improve the diversity of species and quality of habitats in the Natura 2000 areas. The project involved ecological restoration of forests and mires, management of White-backed Woodpecker forests and esker forests, and removal of unused logging roads.

It aimed at improving the conservation status of 33 Natura 2000 sites. The main objectives were:

- to allow forests to become more "natural": to increase amount of dead wood, make tree stand structure more diverse and emulate natural forest fires by controlled burning
- to reduce the degree of fragmentation inside areas by dismantling unnecessary roads in protected areas
- to increase the amounts of sunlight in sunlit habitats of eskers
- to restore natural-like hydrology of spruce mires and other forest-covered mires

The restoration measures have speed up the recovery of the structures of natural boreal forests and of the hydrology of natural forest-covered mires in these areas.

Because of its large scale, this project provides an invaluable best practice experience of forest restoration. This project was the largest forest restoration project in Finland when it began in 2003.

Excavator filling in the drainage ditch in forest-covered mire in North Karelia 2017 © Metsähallitus/M.SIMILA

Creation, restoration methods

The restoration work was based on surveys of the structure of the tree stands and other habitat features in each area. Restoration plans were drawn up for 30 Natura 2000 sites.

Practical measures were carried out on 33 Natura 2000 sites. Different restoration techniques were employed such as:

- Controlled burnings to increase burned and dead wood as well as to initiate improvement of tree stand structure in general
- Blocking of drainage ditches with peat to restore bog woodland, so that water returns to its natural course and drained areas become mires again.
- Felling, girdling and blowing up trees to provide decaying wood
- Removing spruce trees and small rowans from deciduous forests to increase the amount of light to enable Dendrocopos leucotos to breed and feed. White-backed woodpecker is depending on deciduous forests and decaying wood (insect larvae

living in dead trees is a food source for woodpeckers).

Liquefied petroleum gas is used to set the fire. © M.SIMILA

Controlled burning process:

- Preparation of the burning: A particular attention is paid to the area to be burnt, in case there are some valuable species (for example, trunks hosting threatened species may need to be protected from burning). The area to be burnt is delimited carefully, the creation of firebreak corridor is sometimes needed. The burning session is planned carefully (fire extinguish equipment check, water availability near the area, preparation of the burnable material (to adjust the intensity of fire), etc.).
- Organization of the burning: suitable conditions for burnings usually occur between mid-May and August in Finland (not too dry, not too rainy). The direction of the wind must be favourable and predictable, with speed less than 5m/s. The choice of the method and the intensity of the fire depends on the objectives of the burning and on the specificities of the site (shape, size, topography, amounts and nature of burnable biomass, etc.).
- Extinguishing the fire: The best time to extinguish fires is usually at night, when conditions tend to be calmer. Sufficient equipment must be left available at burnt sites to enable any later outbreaks of fire to be extinguished. After any remaining hotbeds have been extinguished, burnt areas must still be patrolled.
- Costs per burning vary depending mainly on size of the area to be burnt. Recent years costs have been about 3000 €/burning area less than 5 ha and about 5000 €/burning area larger than 5 ha. Recent years area of burning site has been 7 hectares on average. Metsähallitus has been able to reduce costs per burning e.g. by improving co-operation with local associations concerning guarding the recently burnt areas.
- In certain cases, high tree density of area to be burnt need to be thinned to 750-1000 trunks per hectare (to improve drying of the area and to ensure fire control). In those cases net income may cover majority of the costs of controlled burning.

More information on the controlled burning process and on the methods to increase the amount of decaying wood can be read in the guidelines 'Ecological restoration and management in boreal forest – best practices from Finland (Similä and Junninen, 2012).

After the burning the edges of the burnt areas are watered carefully. © M.SIMILA

Morning after the burning © M.NIIRONEN

Human and material resources

Large-scale ecological restoration of forests and mires was a relatively new method of conserving biodiversity at the time the Forest Life project was launched, though such methods had been introduced through various small-scale restoration experiments since the late 1980s.

More than 300 forest workers and a number of other forestry employees actively participated in the development of restoration methods. They have been trained for practical restoration work as well as supervisors of natural heritage services. The training, largely carried out as field training, focused on the objectives of restoration and on how these objectives are achieved.

Fire extinguishing equipment were needed for controlled burnings, e.g. water pumps and hoses.

Monitoring and evaluation methods

The impacts of forest habitat restoration measures are monitored to assess how well the restoration objectives have been realised. For this purpose an extensive network of monitoring sites has been set up around the country (17 Natura 2000 sites of monitoring network were restored during the project). Monitored variables include living and dead trees, beetle species composition (1 and 5 years after the measures) and polypore species composition (5, 10, 15 etc. after the measures) at sites where deadwood has been created, and living trees and tree seedlings where small canopy gaps have been opened (5 years after the measures - monitoring is not continued at the moment).

Species feeding or growing on decaying wood, such as beetles and polypores, play a significant role in the decaying process of dead trees. The development of beetle species composition was monitored with window traps in areas where the amount of decaying wood was increased. As soon as a year after the restoration, the number of different beetle species that depend on decaying wood was considerably higher in these areas than in the surrounding forests.

<u>Monitoring of the restored mires:</u>

Finland has set up a national monitoring network for restored mires (mainly during the Boreal Peatland LIFE project in 2010 - 2014). Both the impacts of peatland restoration on hydrology and on biodiversity are monitored.

General monitoring of the restored mires is carried out to visually ensure that the measures have been technically successful and that the peatland is progressively reverting to a more natural state.

Hydrological monitoring includes measuring water levels, analysing water quality (pH, nutrients concentrations, etc.) and monitoring the impacts on watercourses downstream (quantities of runoff discharged from restored peatland).

Biodiversity monitoring aims to identify any changes occurring in plant and moss species communities and their relative abundance after restoration. In selected sites and selected years e.g. lepidoptera, dragonfly, bird and Diptera species have been monitored.

Thymus serpyllum : an important species for several

Water table level rises quickly after restoration measures, recovery of plant species assemblages, tree stand structure and scenery takes years or tens of years.

Special cases of monitoring of beetles and polypores:

The Kakonsalo Natura 2000 site in eastern Finland still has plenty of old living and dead aspens and thus also supports species of beetles and polypores that depend on the aspen. An experiment was made there to determine whether decaying aspen brought to the conservation area would attract these species. The species soon colonised the aspen logs transported to the area, proving that they can be helped by transferring decaying wood to their habitat.

Beetle species seeking their way to burnt forests were monitored on nine Natura 2000 sites throughout Finland during the years 2005 and 2006. On the basis of monitoring, the occurrence of threatened beetle species that favour or depend on fires is governed by the location of the burning site. The further east in the country the burning site is, the faster threatened species appear there and there is also a greater variety of them.

Monitoring of the White-backed Woodpecker:

The winter movements and breeding status of the White-backed Woodpecker were monitored on the Natura 2000 sites of Linnansaari, Kuijärvi-Sonnanen and Puulavesi after management measures had been carried out in the forests providing a habitat for the species. The monitoring proved that the management measures of White-backed Woodpecker forests had been directed at appropriate Natura 2000 sites. The measures had improved the

White-backed woodpecker © M.VARESVUO

feeding and breeding conditions of the White-backed Woodpecker, since one new breeding occurrence was found on the Linnansaari Natura 2000 site and, judging from the spoor, White-backed Woodpeckers have also discovered the managed forests on the Puulavesi Natura 2000 site.

White-backed woodpecker populations are monitored yearly all over the southern Finland. The size of population has increased remarkably thank to active species conservation (active management of habitats suitable for the species and protection of habitats). Happy coincidence have been wanderings of the specimens (some years even huge eruptions) from east and south east.

Photo monitoring of the restored forests and mires also permits to evaluate the efficiency of the restoration measures. For this project no photo monitoring was done after the end of the project, but photo rounds were used to monitor the changes during the project.

Description

The project started in December 2002 and ended in December 2007.

Partners

The project was coordinated by Metsähallitus, Natural Heritage Services, Southern Finland.

- Technical partners: WWF Finland, the UPM Kymmene Corporation, the Karelian Brigade of the Finnish Defence Forces, and also Metsähallitus Forestry, Metsähallitus Laatumaa, Metsähallitus, Natural Heritage Services, Lapland, Natural Heritage Services, Ostrobothnia.

- Scientific partners : the University of Joensuu

- Financial partners : WWF Finland, the UPM Kymmene Corporation, the Karelian Brigade of the Finnish Defence Forces, the University of Joensuu, and also Metsähallitus Forestry, Metsähallitus Laatumaa, Metsähallitus, Natural Heritage Services, Lapland, Natural Heritage Services, Ostrobothnia.

Costs and financing

As a LIFE project, the project was financed according to usual LIFE projects financing rules. The total budget of the project was 3,680,467.00 €. Each partners co-financed the project and the EU contribution was 1,840,234.00 €.

Overall assessment

In mature forests, a sustainable supply of decaying wood was initiated by felling, girdling and blowing up trees on 2700 hectares. 350 hectares of forests were treated with controlled burning. Canopy gaps were created on 2880 hectares, which will improve varied age structure of the tree stock as new seedlings gradually appear in clearings.

200 hectares of White-backed Woodpecker forests on the Natura 2000 sites of Linnansaari, Puulavesi and Kuijärvi-Sonnanen were managed by removing spruces and small rowans from deciduous forests in order to increase the amount of light in them. Decaying wood was increased by both girdling and felling birches.

The esker forests on the Maakylä-Räyskälä Natura 2000 site were becoming over-grown. Therefore 300 hectares of sunny habitats were recovered by small-scale

controlled burning, by making small clearings and by increasing decaying wood.

Drainage ditches of forest-covered mires on an area totalling around 400 ha on 10 Natura 2000 sites were dammed and filled in.

On the Maakylä-Räyskälä Natura 2000 site, 1 km of unused logging roads were removed, and on the Rokua Natura 2000 site, 2 km of such roads were removed. Roads in the Rokua area were blocked from traffic by felling trees across them in conjunction with the forest restoration process. In the Maakylä-Räyskälä area, the surface of the roads was ripped with an excavator and the soil was then levelled out to follow the contours of the terrain. The growth of tree seedlings on the road tracks is thus speeded up as seeds will germinate better in tilled soil.

The project has been awarded the title of "Best of the best" from a short list of 26 "best" LIFE nature projects in 2007-2008.

Amount of dead wood was increased 5-35 m3/ha. Common polypore species colonise produced dead wood first and start succession of dead wood. For beetle species, burnt areas are the most attractive: fire-dependent or burnt-area oriented species inhabit area quickly after burning (e.g. *Boros schneideri*) and production of dead wood continues gradually long after burning. This creates habitats for various saproxylic species.

Finnish spruce-dominated mire before and after restoration. © M.SIMILA

STRONG POINTS	WEAK POINTS
— Large and effective monitoring network allow to see the impacts of restoration projects for boreal forests in the whole country. — Large and effective monitoring network of restored peatland sites, based mainly during the Boreal Peatland LIFE project in 2010-2014, shows the ecological effects of mire restoration. — A lot of work has been done to improve social acceptance and status of ecological restoration, the role of dead wood and controlled fire for forest ecosystem (web pages, brochures, press, radio and television, public information events, organization of a restoration-themed nature trail, information board in many areas, etc.) — Many other restoration (LIFE) projects have been implemented after this one. — Experience gained from this project and other similar projects shows that controlled burning is the best and the most recommended method to restore boreal forests. — Effective communication has been done around the project: web pages, brochures, and a DVD (Back to nature) were produced and the project was featured on more than 150 occasions. — A restoration-themed trail was built on the Hevonniemi Natura 2000 site. — Restoration methods are better known by the general public	— Controlled burning requires optimal weather conditions and a lot of skilful labour. Only a few areas can be burnt per year. — Controlled burning requires special attention to valuable species that could be on site — Co-project of several organisations: fluctuations in general economic situation may affect the own financing of organisations. Prioritisation of the project measures is important within organisations. — Changes in the habitat characteristics of restored sites is a slow process, and monitoring conducted during the project may not continue long enough to detect any changes. Continuity of monitoring actions should be ensured also when the project has ended.

IMPROVEMENTS - ADVISES

- Climate change leads to more storms and windy days which in turn leads to more dead wood. That is why Finland has almost completely given away girdling and felling trees by timber jacks.
- If increase of dead wood is required and burning is not possible action, excavator is the best tool to produce dead wood (root connection remaining and decaying process resembles more natural than if tree is felled by chain saw).
- Controlled burning is an ideal way to restore boreal forests. Competent burning managers and skilled labour should be ensured through education and field training.
- Monitoring is important to see and show the ecological effects of the restoration measures. Monitoring should last long enough to see the long-term effects of restoration in addition to short-term effects.

Finnish spruce-dominated mire before and after restoration. © M.SIMILA

Perspectives

Continuation

Restoration of forests and peatlands, ecological management of white-backed woodpecker habitats as well as recovering of sunny habitats on eskers have been continued through several other remarkable LIFE-projects (such as the Boreal Peatland LIFE project in 2010 -2014, the Species rich LIFE project in 2011-2016, Light & Fire LIFE in 2014-2020, Hydrology LIFE in 2017-2023 etc.) in Finland. Monitoring of dead wood succession and polypore species composition is still ongoing.

Transposability

Controlled burning is the best method for forest restoration at least in boreal zone. It is relatively widely accepted in Finnish society, but e.g. in Central Europe probably more criticized. Active informing is necessary if the method is applied.

Restoration of mires has to be planned and completed as hydrological entities. Vegetation and other characteristics of mires are dependent on water supply coming from catchment area.

In Finnish conservation areas even large amounts of dead wood are widely tolerated. Awareness of the importance of diverse dead wood composition also outside the conservation areas requires continuous communication with the general public. Networking with other LIFE projects showed that this topic can be more sensitive in other countries even in conservation areas and that communication with public is really important everywhere.

This pine-dominated forest intended to be restored by timber jacks but nature was quicker. The jet stream felled trees on area of 25 hectares in 2004. Dead wood supply in sunlit habitat is ensured for a couple of decades. Structure of new tree generation (photo taken 8 years after the storm) is completely natural. © M.SIMILA

Publications

Similä Maarit, 2007: Forest Life 2002 – 2007, Final report. 24p.

Komonen Atte, Kuntsi Satu, Toivanen Tero and Janne S. Kotiaho 2014: Fast but ephemeral effects of ecological restoration on forest beetle community. Biodiversity and Conservation 23 (6) pp 1485-1507.

Pasanen Hannes, Rehu Virve, Junninen Kaisa and Jari Kouki 2015: Prescribed burning of canopy gaps facilitates tree seedling establishment in restoration of pine-dominated boreal forests. Can. J. For. Res. 45: 1225-1231.

Pasanen Hannes, Junninen Kaisa and Jari Kouki 2014: Restoring dead wood in forests diversifies wood-decaying fungal assemblages but does not quickly benefit red-listed species. Forest Ecology and Management 312: 92-100.

Similä Maarit and Junninen Kaisa 2012 : Ecological restoration and management in boreal forests - best practices from Finland. Metsähallitus Natural Heritage Service. Available at: < https://julkaisut.metsa.fi/assets/pdf/lp/Muut/ecological-restoration.pdf >

Similä Maarit, Aapala Kaisu and Penttinen Jouni 2014 : Ecological restoration in drained peatlands - best practices from Finland. Metsähallitus - Natural Heritage Services). Available at: < https://julkaisut.metsa.fi/assets/pdf/lp/Muut/ecolres-peatlands-1.pdf >

Video:

https://www.youtube.com/watch?v=X2XMzjsdNa4&feature=c4-overview&list=UUD6wtnaysTMpT-zcA7laJYg

Realized by: International Office for Water

With the financial support of: AGENCE FRANÇAISE POUR LA BIODIVERSITÉ ÉTABLISSEMENT PUBLIC DE L'ÉTAT

and the technical support of the French Ecological Engineering Resource Centre: Centre de ressources GÉNIE ÉCOLOGIQUE

Building with Nature in Indonesia

N°6

IN A NUTSHELL

Identity of the organisation

Organisation: "Building with Nature Indonesia" is a programme from Ecoshape, Wetlands International, the Ministry of Marine Affairs and Fisheries (MMAF), Ministry of Public Works and Human Settlement (MPWH), Witteveen+Bos, Deltares, Wageningen University & Research, UNESCO-IHE, Von Lieberman, Blue Forests, the Diponegoro University, and local communities.

Website: www.indonesia.buildingwithnature.nl

Contact: Femke Tonneijck, Wetlands International, PhD, Programme manager, femke.tonneijck@wetlands.org, +31 (0) 318 660 910

Site identity

Localisation: Demak district, Central Java, Indonesia

Specificities: In Northern Java, communities are suffering from coastal erosion along hundreds of kilometers of coastline. In the district of Demak, in some places, more than 3 km of land have already been swallowed by the sea, including entire villages.

Challenges : The Demak district, near the multi-million city of Semarang, has lost most of its protective mangrove forests as a result of the massive switch from rice production to aquaculture in the 1980's, which has caused severe coastal erosion. As a consequence of mangrove loss, biodiversity losses as well as GHG emissions are substantial.

Areas : coastal environment

Action type : people and goods, restauration or rehabilitation

Action framwork: Climate change adaptation, management of nature areas, risk management, land planning, spatial planning works

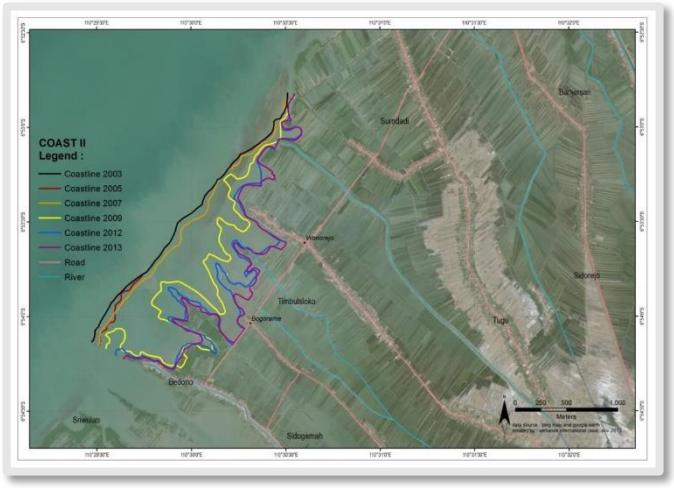
History and context

In Northern Java, the lives and livelihoods of 70,000 people are at risk of being engulfed by the sea if erosion is not put to a halt. Coastal floods are increasing and have destroyed infrastructure and productive land. Salt water intrusion pollutes drinking water, reduces aquaculture profits and affects agriculture. Over the last decade, income has decreased for shrimp farmers and fishermen respectively. This decline in well-being, security and self-reliance has been further exacerbated by the collapse of natural resources – timber, fuel, fish – which used to account for more than 50% of their income. Besides, sea level rise is projected to flood 6 kilometers inland by 2100In the long run, 30 million people may suffer from coastal erosion in Java.

The main causes of the erosion problems are the removal of mangrove belts for aquaculture development, coastal infrastructure which disturbs sediment build up from offshore, and groundwater extraction which causes land subsidence, and river canalization.

Mangrove belts play an important role in coastal safety along muddy coasts. They are dynamic systems, with sediment naturally eroding and accreting as a result of wave and tidal action. When a mangrove green belt is wide and self-maintaining, periods of erosion can be compensated for and the coastline restores naturally. They also protect against wave impacts and flooding indirectly by helping to accrete land and hence increase shore elevation and slope. Mangroves also contribute to sediment consolidation/compaction. Mangroves are also breeding grounds for fish, and rich sources of timber and non-timber forest products. In some places mangroves generate revenues from tourism and recreation.

Coastal managers typically use "hard" engineered solutions to combat erosion problems and related hazards which do provide important protection but are too expensive and complicated to design along muddy coasts. They do not address the root causes and fail to restore environmental conditions and ecosystem services that are crucial for a productive aquaculture and fisheries sector. Large scale mangrove planting efforts have failed, hampered by erosion and wave action. Protection measures are implemented ad hoc without coherent strategy.



Demak from outer space and evolution of the coastline © Wetlands Internationl

Instead of fighting nature with dams and dikes, Building with Nature solutions work with and along the dynamics of nature. For example, by restoring ecosystems so that they once more provide protection against extreme events and offer valuable 'natural capital' (shell-fish, timber or recreational opportunities for example). Different examples of Building with Nature solutions can be seen at : https://www.ecoshape.org/en/projects/

In Demak, the public private partnership "Building with Nature Indonesia" introduces this approach to address the root causes of erosion, integrating mangrove and river restoration, small-scale hydraulic engineering and sustainable land use (technical and socio-economic measures). Moreover, Building with Nature solutions are climate-adaptive, and often cheaper to construct and maintain, compared to static infrastructure solutions. The

environmental co-benefits enable more productive and multi-functional land-use. Local stakeholders – including communities – are involved in design, construction and maintenance of measures.

Presentation of the project

Issues and objectives

The project has different objectives:

- Rehabilitation of mangroves :

The principal objective is to build a stable coastline with reduced erosion by stimulating the rehabilitation of mangroves of the most vulnerable parts of 20 kilometers of affected coastline in Demak District.

For this purpose, permeable structures are constructed in front of the coastline, to dampen the waves and capture sediment (see next section).

Natural mangrove restoration supports the development of mangrove forests with different species. This is because not all species can equally withstand the submerged conditions, wave exposure and salinity occurring at the seafront. Natural mangrove succession starts with pioneer species that facilitate colonization by many other species and results in a great variety in root types, tree sizes, foliage and fruits, fulfilling different functions and attracting diverse (fish) fauna. This in turn results in the provisioning of multiple goods (timber, fodder, honey, fruits, and fish) and services (enhanced coastal protection, carbon storage, water purification, fisheries enhancement). Ecologically restored forests are also likely to be more resilient to change because of this. For more information see the brochure: 'Mangrove restoration: to plant or not to plant', which has been developed by the Building with Nature Indonesia consortium.

Where the coastline is not yet eroded the project stimulates pond conversion into mangroves in close participation with local communities.

• Develop a sustainable aquaculture:

Mangrove restoration will only sustain in the longer term if prosperity for local communities is created simultaneously. In the context of Demak, the project therefore revitalizes environmentally friendly aquaculture productivity and introduces mangrove based livelihoods, while restoring coastal safety. That way, prosperous communities are able to sustain the mangrove greenbelt that they rely on for their coastal safety. The project is putting in place a model for sustainable aquaculture that provides space for mangrove restoration. Measures include:

- the conversion of 50 ha of ponds into greenbelt
- setting back pond bunds along rivers to create space for mangroves in another 100 ha (so-called mixed mangrove aquaculture)
- revitalizing 300 ha of aquaculture ponds by adopting environmentally friendly practices such as decreased use of chemicals.

The introduction of the innovative mixed mangrove aquaculture system for the first time in Indonesia is exciting. This system is different from the silvofisheries system that is traditionally applied, because the mangroves and aquaculture ponds are separated. Due to this separation, aquaculture productivity is optimal, while the surrounding mangroves reduce the spread of disease agents, purify water and maintain their coastal safety and fisheries enhancement functions. In traditional silvofisheries systems, mangroves are planted on pond

bunds or inside ponds and as such are not connected to open water. Such enclosed mangroves cannot filter water nor provide food and shelter for fish species.

The aquaculture measures in the project will be governed under community bylaws and rooted in community development plans and government master planning for sustainable development.

- Address subsidence problems:

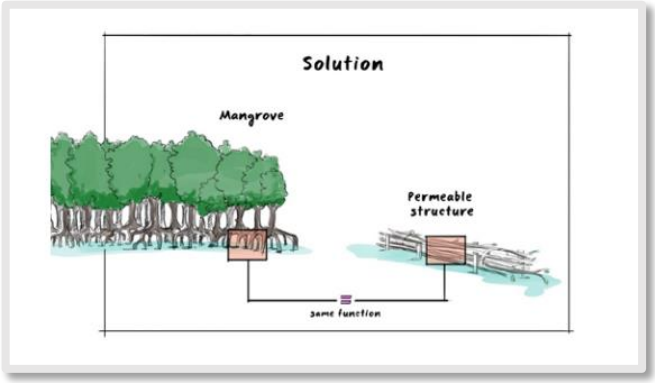
The project also stimulates policy dialogue on land subsidence problems. In 2017, the project Consortium observed that the problems with land subsidence in Demak affect the entire 20 km coastal stretch of the project. They warned that ultimately, sedimentation rates may not keep up with such high levels of subsidence. Uncontrolled groundwater abstraction is a global cause of soil subsidence in many areas of the world and is causing land subsidence in coastal areas throughout SE Asia. Informed decisions can only be made by mapping water demands, water availability, water safety and through dialogue. It ultimately calls for an integrated water management plan for Demak and Semarang. The Building with Nature Consortium therefore studied the potential to shift to surface water and severely reduce ground water extractions. The Consortium has presented a first preliminary evaluation of water availability and an exploration of possible solutions in Demak rivers to create dialogue among stakeholders and proposes that all the water demand is being mapped, because an Integrated Water Resources Management Plan is urgently needed to seize such opportunities. Download the summary of the IWRM study.

Creation, restoration methods:

- Technical measures:

The first step is to restore the sediment balance to stop the erosion process and regain a stable coastline. More sediment needs to be deposited on the coast than the amount being washed away.

To this end, permeable structures made of local materials such as bamboo, twigs or other brushwood are designed to function as sediment traps. These structures let the sea and river water pass through, attenuating the waves rather than reflecting them. As a result, waves lose height and energy before they reach the coastline. The permeable structures also let mud from the seaside pass through, while creating calm water conditions allowing net settling of fine sediments. This way the structures increase the amount of sediment trapped at or near the coast. The mangroves stabilize sediment, further build up the soil and reduce salt water intrusion and flooding extent landward.



Permeable dams mimic the structure of mangrove root systems to trap sediment and dampen waves © EcoShape

Permeable structures © Nanang Sujana

These poles must be durable for the entire lifetime of the permeable structure (5 years or longer). They will be removed when their function is not needed any more in

the project. Two materials are used for the vertical poles: bamboo betung and PVC filled with concrete. The bamboo poles are covered in the tidal zone with wrapping (carpet and tarpaulin) to protect against damage by shipworm. In the first years local wood was used, but more than half of the poles collapsed within one year due to damage by shipworm. PVC poles filled with concrete were then used. Concrete makes the poles more durable. However, PVC degrades due to sunlight and saline water (but it is difficult to monitor this deterioration, because the poles are difficult to reach). It should be investigated whether HDPE is a better alternative.3.33 poles are needed per meter as there are 2 rows of poles and every 0.6 m a pole is placed.

In 2017 the Building with Nature Consortium placed 1.7 kilometres of semi-permeable barriers, on top of the 3.5 kilometres that were built and maintained in 2015 and 2016. The Ministry of Marine Affairs and Fisheries has in total placed 11 kilometres of structures in 12 districts of Northern Java since the start of the project, worth 1.4 mln EUR.

Permeable dams should always be placed in the back of the area to be restored, advancing step by step in seaward direction. If not, too little sediment may be trapped, yielding the risks of water logging. Permeable dams are in particular effective during the stormy season (December – February), because the larger waves during the monsoon bring in more sediment to be trapped while the dams protect the hinterland from further wave attack. Once the erosion process has stopped and the shoreline has accreted to sufficient elevation, mangroves are expected to colonize naturally. The mangroves can then further break the waves and capture sediment and are intended to eventually take over the role of these dams. Hence, the permeable dams at least need to stay in place long enough for mangroves to take over, which is a sum of the sediment accretion rate (2 – 5 years) and rate of mangrove recovery (3 – 5 years). At the targeted front of the mangrove green belt, more permanent permeable structures are required, as these will form the primary sea-defence (means to dissipate wave energy) until also the muddy foreshore (mudflat) is restored.

Sediment accumulating inside the permeable dams © TONNEJICK F.

A technical guideline on permeable dams will be soon available.

Planting mangroves has often failed in this region, as the erosion process is in such an advanced stage that seedlings simply wash away because the water is too deep and waves are too strong. Still, mangroves are remarkably robust and opportunistic species, and they may recover even in eroding areas, as long as appropriate biophysical and social conditions are established. For successful restoration it is most effective to recreate the conditions for natural regeneration to take place rather than to do planting. Naturally recruited Avicennia grows faster than planted species or seedling.

- Socio-economic measures:

The project develops and introduces sustainable aquaculture and livelihoods diversification (crab & shrimp farming). 10 community groups are supported through farmer field schools and by providing resources (financial support) to initiate new aquaculture management practices and livelihood diversification. These improved practices will directly revitalize 300 ha of land for 300 households (based on a conservative estimate of 1 ha per household), increasing average aquaculture productivity with 50%, by adjusting pond lay-out and management, by reducing fertilizer and pesticide inputs, by making optimal use of mangrove services like water purification

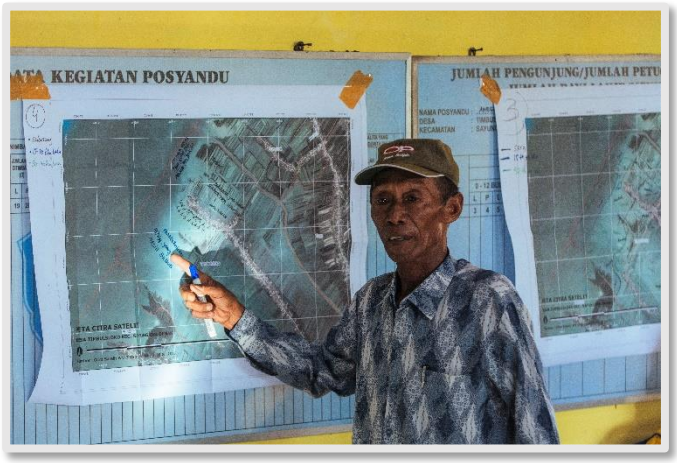
and by diversifying livelihoods activities. Based on experiences in Indonesia and Vietnam, income derived from the ponds is expected to have risen to 5000 EUR ha by year.

Community funds will be established that:

- absorb savings from increased pond productivity (5%) in support of long-term coastal belt maintenance and up-scaling of sustainable land-use management measures beyond the project lifetime
- can absorb government support to local communities for coastal protection and sustainable land-use.

Communities have full ownership over enhanced aquaculture production systems and the hardware that will be put in place during and after the project. The reclaimed land will be managed as community-based protected areas (as agreed between communities and the local government), with opportunities for sustainable use of natural resources. The reclaimed mangrove belt will be formally owned by the government as per Indonesian law.

Enhanced capacity and awareness is required to enable and stimulate the target group and other actors to take an active role in planning and implementation of Building measures. Three different training curricula are developed and delivered, targeting government, private sector and communities. Trainings will address both technical, socio-economic and institutional (Integrated Coastal Zone Management, group organising etc.) matters.



Costal Field School © Boskalis

Human and material resources

The technical measures are implemented and maintained by community groups (20-30 each) from 10 villages, with support from Indonesian contractors and under general supervision by project partners. In return for active engagement in conservation and restoration measures, communities receive (financial) support to develop sustainable livelihoods that will generate income. The payments are conditional. This means that payments to communities will only be provided subject to successful restoration (*Biorights incentive mechanism*).

Community involvement in the construction work © Boskalis

Ownership and provisions for maintenance of the structures will be formalized during the project in co-management arrangements between communities and the local government. Communities will take full ownership over the structures ensuring their long-term maintenance. Maintenance costs will be covered via community-managed development funds.

Monitoring and evaluation methods

Different methods were used to monitor biophysical and socioeconomic effects, such as coastal risk reduction, land and water quality improvements, mangrove re-establishment and livelihood gains.

Different indicators and variables are monitored: restoration of the sediment balance, reduced salt water intrusion, decreased erosion rates, re-establishment of mangroves, recovery of pond fisheries production, improvements in income and livelihoods diversification.

Satellite imagery is used to assess coastline change and erosion/deposition areas, while drone images offer a means of assessing on-the-ground mangrove recovery.

Interviews and discussions provide also data about changes in local livelihood status and ecological conditions. Local communities are actively engaged in collecting and recording monitoring information (for example through taking part in regular dialogues, helping with the collection of field measurements, keeping logbooks and other records). The principle of stakeholder participation plays a key role in the technical monitoring protocol.

Monitoring is carried out on an ongoing basis, with data collection taking place at regular intervals. Monitoring allows to continuously update instructions for the design, construction, and supervision of the eco-engineering measures.

Description

The project will be completed by June 2019.

Facilitation

Regular reports are submitted to the donors, which include the Dutch Sustainable Water Fund, The International Climate Initiative (IKI) of the German Environment Ministry (BMUB) and Waterloo Foundation. The Indonesian Ministries are partners and contribute to the reporting.

Partners

The team is composed of project managers (Wetlands International and Ecoshape), private sector parties and specialists, both international and Indonesian. There is close collaboration with local communities.

Type of partner	Name	Role
Non-governmental organizations	Wetlands International	Manages the partnership, coordinates field-based and outreach activities, empowers local communities, facilitates stakeholder dialogue, give ecological expertise
	Blue Forests	Organizes coastal field schools to develop and implement aquaculture measures with communities.
Knowledge institutes	Deltares	Responsible for the design and monitoring of Building with Nature interventions
	Wageningen Marine research	
	Local University of Diponegoro	Contributes to the design and supports on the ground monitoring.
Consultancy and engineering firms	Witteveen+Bos	Manages the development of the guidelines and facilitates project replication.
	Boskalis	Global services provider operating in the dredging, maritime infrastructure and maritime services sectors
	Von Lieberman	Provides technical advice on the basis of experiences derived from a similar project
	Van Oord	Leading international contractor, specialized in dredging, marine engineering and offshore projects
Local stakeholders	Demak Communities	Are involved in the implementation and maintenance of technical measures.

The project shows that close engagement with local communities and other stakeholders, at all levels from design through to implementation, is vital to address root causes and to deliver community benefits.

Costal Field School © Boskalis

Costs and financing

Total funding volume: € 5.069.657 (own funds: 50,000€; external funding: 1.976.000€, BMUB (German Federal Ministry for the Environment, nature Conservation, Building and Nuclear Safety) funding 3.043.657€)

The programme is further supported by Waterloo Foundation, Otter Foundation, Top Consortia for Knowledge and Innovation, Mangroves for the Future, and with contributions by all partners.

Overall assessment

The progress and developments with regard to the Building with Nature pilot in Demak can be summarized as follows:

The Building with Nature measures implemented have in principle been successful.

Key successes that enhance coastal resilience and that have clear replication potential are:

- The Biorights incentive mechanism; as it has successfully engaged communities in mangrove restoration and aquaculture revitalization (community groups even giving up land for restoration).
- The Coastal Field Schools; as these have enhanced and diversified productivity and income of local communities by introducing best practices for aquaculture.

- The permeable structures; as they are effectively trapping sediment aiming to restore the conditions for mangrove restoration.

However, subsidence (having several causes, among which groundwater extraction) is much more severe than previously anticipated and stretching much further along the coast than previously thought. This may be exacerbated by further industrial/infrastructure development and population growth.

We may have reached a threshold where coastal restoration and aquaculture revitalisation may no longer be feasible at the landscape scale, unless subsidence is stopped. This requires further investigation as well as urgent action. Traditional infrastructural measures may also not be able to cope.

There is a shared responsibility by all stakeholders to address subsidence problems by stopping groundwater extraction, enhancing integrated water resources management and by joining forces to restore mangroves and revitalize aquaculture.

Although it is not clear whether the envisioned landscape scale coastal restoration and aquaculture revitalization is still feasible due to the severity of subsidence, the Building with Nature measures will still enhance the resilience of the coastal communities and ecosystem in the shorter term and at a smaller scale, thus softening and delaying the impact of hazards.

Hence, the project will continue the implementation and maintenance of measures as agreed in Biorights contracts with 10 community groups.

The project will also prioritize awareness raising among communities about subsidence and the need to address this, through integrated coastal zone and water resources management across Demak and Central Java, increase attention for disaster preparedness of communities (including e.g. adaptation or transformation of livelihoods) and will stimulate (policy) dialogue about subsidence at the national level.

The challenges in Demak emphasize the need for holistic solutions like Building with Nature, in combination with integrated water resources and coastal zone management.

Hence, the project will increase efforts with regard to mainstreaming Building with Nature across Indonesia, including through capacity building and training.

Tangible results policy embedding:

- Master plan for sustainable development of Demak district - including Building with Nature Indonesia measures developed with and endorsed by Taskforce Integrated Coastal Zone Management led by planning agency of Central Java and involving all relevant stakeholders.

- Master plan and Building with Nature approach embedded in Central Java Provincial policies (spatial plan and mid-term development plan 2019-2024 and provincial mangrove strategy).

- Village development plans and regulations on land use rights, protected areas and coastal zone management developed and adopted by 10 communities and formalised with local government.

STRONG POINTS	WEAK POINTS
Protection of a specific wetland type widely spread over coastal areas in the World	
Strong involvement of local communities including in the long term	
Identification of positive impact for local people (income and welfare) to promote the approach	
Integrated approach with involvement of all stakeholders/parties from national to local	Use of PVC filled with concrete(unnatural, heavier and more expensive than bamboo)
Use of local resources (bamboo, sediment…)	Solutions may not be able to cope with severity of subsidence
Helping communities to adapt to climate change and cope with disaster risk	The sediment balance is only monitored in the project area and not in other locations, where the process could have an impact.
embedded replication and scaling up of the approach	
building of a community of practice	
increased yields of aquaculture, reduce pressure on mangrove and ponds creation	
favouring natural recovering processes instead of targeted planting	

Mangrove recovery behind permeable dams © PT. Prospek Empat Dimensi

Perspectives

Continuation

The challenges in Demak emphasize the need for holistic solutions like Building with Nature, in combination with integrated water resources and coastal zone management. This year a Building with Nature secretariat was created in Indonesia, facilitated by the Ministry of Marine Affairs and Fisheries. It will disseminate the Building with Nature approach across Indonesia, by providing practical design guidelines, training and policy recommendations. A help desk facility will provide on-the-job guidance on all aspects of the project life cycle of existing and future Building with Nature projects. A high-level network of champions will be created to facilitate outreach in media, policy fora, and working groups for wider uptake of Building with Nature in Indonesia.

The consortium aims to turn this project secretariat into an independent platform to engage new members from government, private sector, knowledge institutes and civil society and initiate new pilots in different settings. In the future the Platform could become a Centre of Excellence in the South East Asia region providing advice on nature-based solutions.

Transposability

- Learning by doing:

Building with Nature is innovative and site specific, operating in areas with limited systems understanding and dynamic changes. Therefore the project applies a learning-by-doing strategy. It is therefore flexible and adaptive and is updated frequently with lessons learned. The project partners share their knowledge and lessons learnt widely to support sound replication of the approach.

- Replication and scaling up:

While specific designs for Building with Nature are highly site-specific, depending on local conditions, the general rationale behind the approach as well as the required process behind roll-out of the approach are readily replicable, provided that a conducive environment and sufficient stakeholder capacity are in place.

There is a "Building with Nature" solution in every setting, combining green and grey infrastructures in an optimal mix, alongside other measures of risk reduction. The project aims for replication and scaling up of the Building with Nature philosophy and approach to other rural and urban areas, in Indonesia and across the world. This is done through capacity building, knowledge exchange, exchange visits and embedding in policies and planning. The initiative is strongly supported by the Indonesian government and local communities.

Publications

ECOSHAPE. Brochure: Building with Nature Indonesia – meet the partners. 2p. Available at:

https://www.wetlands.org/publications/building-with-nature-indonesia-meet-the-partners/

ECOSHAPE. Brochure: Building with Nature Indonesia – reaching scale for coastal resilience. 6p. Available at: < https://www.ecoshape.org/uploads/sites/2/2016/07/building-with-nature-in-indonesia-1.pdf >

ECOSHAPE. Mangrove restoration: to plant or not to plant? 12p.

Available at: < https://www.ecoshape.org/uploads/sites/2/2017/02/16.0506-Wetlands-English-lowres_2.pdf >

TONNEIJCK F., WINTERWERP H., VAN WEESENBEECK B., DEBROT D., RUSILA NOOR Y., WILMS T. Design and Engineering Plan. Building with Nature Indonesia – Securing Eroding coastlines. 65p. 2015

Available at: < https://www.ecoshape.org/uploads/sites/2/2016/07/Ecoshape-2015-Result-1-5-Design-Engineering-Plan-v7-0-LAYOUT-Nature-style_2.pdf >

GIZ. Indonesia case study 17 – Evaluating the biophysical and socio-economic effectiveness of hydrid "Building with Nature" coastal adaptation in Indonesia. 5p. 2017.

Realized by: International Office for Water

With the financial support of: AGENCE FRANÇAISE POUR LA BIODIVERSITÉ ÉTABLISSEMENT PUBLIC DE L'ÉTAT

and the technical support of the French Ecological Engineering Resource Centre: Centre de ressources GÉNIE ÉCOLOGIQUE

Restoring Monarch's natural habitat

N°7

IN A NUTSHELL

Identity of the organisation

Organisation: Land Life Company

Website: www.landlifecompany.com

Contact: Arnout ASJES, Director, +316811622906, a.asjes@landlifecompany.com

Site identity

Site: The Monarch Biosphere Reserve

Location: Zitácuaro, Mexico. The Monarch Biosphere Reserve is located in the Trans Mexican Volcanic Belt pine-oak forests, on the border of Michoacán and the State of Mexico, around 100km north of Mexico City.

Specificities: The reserve in Michoacán contains the highest elevations in the state, including peaks that reach 2,700 masl (metres above sea level). The climate is classified as being temperate and somewhat moist with a rainy season in the summer

Challenges: The Monarch Biosphere Reserve in the mountains of Michoacán is a designated UNESCO World Heritage site. Every autumn, an estimated 1 billion monarch butterflies arrive from Northern America to breed and spend the winter in the so-called 'Zona Nucleo', the core habitat of the Monarch butterfly species.

Status: The winter roosts in both Mexico and California were declared to be threatened phenomena by the International Union for the Conservation of Nature and Natural Resources (IUCN) in the IUCN Invertebrate Red Data Book.

Areas: Woodland area, mountainous environment

Action type: Creation of ecosystems/areas, Restoration or rehabilitation (towards the ecosystems historical trend or repairing key functions), species reintroduction, translocation

Action framework: Climate change adaptation

History and context

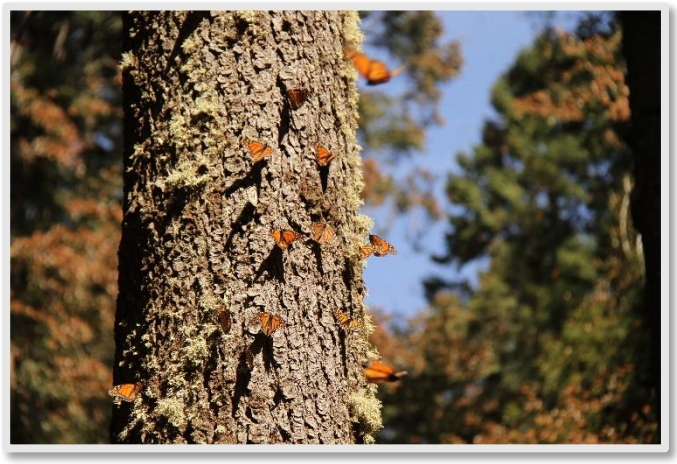
The Monarch's fiery orange and black wing pattern is instantly recognizable and reflected in childhood drawings around the world. This beautiful, large, and iconic species of butterfly has an extraordinary migration pattern, flying from Canada all the way to Mexico.

The Monarch butterfly © The Land Life Company

Having completed their mammoth journey, the Monarchs arrive in the hills of Michoacán, Mexico, where they settle down for a few months to rest and breed in the protected nature reserve. The livelihood of the Monarch butterfly depends entirely on the Oyamel tree, or *Abies religiosa*, that grows here. Several hundred million Monarch butterflies spend the winter clinging to these fir trees that protect them from the rain and chill throughout the winter months.

Today, the protected area where the Monarch butterfly can live and reproduce is under threat, with Oyamel trees illegally harvested by people who do not realize their immense value to the surrounding ecosystem. Also, a major forest fire in 1978, followed by seasonal rains, washed away fertile soil. This has meant that hundreds of thousands of tree seedlings, planted in an effort to restore this area in the last 30 years, have died and natural restoration is not happening at a sufficient rate to fully restore the Monarch habitat. More recently, the trees have been attacked by a disease from a beetle. Climate change is also an important factor currently affecting monarch habitat.

The disappearance of the Oyamel forest is not only affecting the Monarch butterfly but the local communities that rely on the forest for their livelihood, water management, and protection. They are taking action and have started 24-hour surveillance to stop illegal logging, but still lack the funds or technical knowledge to restore the degraded lands surrounding their homes.



Monarch butterflies relying on the oyamel trees in the bioshpere reserve to protect them from the winter chill. © The Land Life Company

Presentation of the project

Issues and objectives

Illegal harvesting of oyamel trees (Abies religiosa) and massive wildfires have resulted in severe degradation of these hilltop ecosystems. Restoring the Oyamel forests is crucial to ensure the species' survival. The reforestation of the Zona Nucleo (core habitat of the Monarch butterfly) started the first week of April 2016 with 10.000 seedlings. The seedlings used came from a local nursery (las novias del sol), operated by WWF.

Creation, restoration methods

The Cocoon is an incubator for tree seedlings, enhancing growth conditions towards tree establishment especially in primarily drier regions. The harsh conditions in these regions are hostile to vulnerable tree seedlings in particular, explaining the low survival rates in conventional plantings. The Cocoon stimulates deep rooting thus bridging the dry surface soil, and shelters shoot growth against excessive transpiration, together markedly increasing tree survival and performance. Once tapping into moister soil substrata, trees have become properly established, resulting in a strong and resilient tree, well prepared for an independent life.

The basic proposition is that no watering, inspection or maintenance is required post planting. The Cocoon consists of a donut-shaped water reservoir and lid, wicks and a tree shelter.

Installation of the COCOON with local people © The Land Life Company

The water reservoir with lid are made of recycled cardboard and fully biodegradable materials (heat is

applied in the process to promote hydrogen bonding between the paper fibres). Both parts are buried in the soil upon a one-off fill with water (~ 25 liters) while planting a small tree seedling in the middle. This water is trickled down just below the seedling's root ball using wicks. A paper based shelter is placed to protect the young tree shoot against high irradiation and desiccating winds as well as attack by small rodents. The Cocoon's lid prevents evaporation losses of the water stored inside, and keeps weeds away from the direct vicinity of the seedling, eliminating competition for water and light. As such stored water in the Cocoon is effectively used by the tree only.

The Cocoon dissolves completely in the soil. The only material that is left after this process is a very small amount of nylon from the wicks that transport the water from the reservoir (The Land Life Company is currently working on options to use organic materials for this).

The tree seedlings used are preferably between 20-40 cm tall (typically 1 year old), with a limited number of leaves, to curb transpiration losses. Additionally, younger trees generally are less affected by undesired root girdling or J-rooting. As such, young trees, take deep roots upon planting, which enhances the tree's resilience during drought episodes. The seedlings, while growing tall, adapt to local windy conditions, resulting in firm stems. Obviously, there is a logistic and cost saving of not using continuous irrigation. Longer term, these trees are resilient against lack of irrigation water and are also less prone to diseases, especially when inoculated with mycorrhizae.

Human and material resources

100 of workers participated in the planting. Donkeys, spades and picks were also needed. Planting a tree requires around 7 minutes. It took around 6 weeks to plant all the trees.

Installation of the COCOON with local people © The Land Life Company

Monitoring and evaluation methods

After the initial 2-3 months, trees are excavated to measure the root system, in terms of width and depth. These analyses will be conclusive for the long term success of the tree. Once the roots are over 1 meter deep and spread widely in hair roots, the tree is properly established and will have a high chance of surviving longer term.

Control groups of 30 trees (with same treatment) at each location are planted to compare the survival rates and growth rates to the Cocoon. These trees will be watered once at planting, but not after that.

Ongoing monitoring can be completed through hiring local community members.

Tree vigor is a health indicator, also giving insights on survival rates. Survival rates during tree establishment in the first year can mainly be attributed to the Cocoon. Survival rates in subsequent years may clearly also be affected by extreme drought or other factors like grazing and fire, all beyond the scope of the Cocoon. Vigor is assessed by the following semi-quantitative scores during

their normal growing period (1 - 3 years) (i.e. no vigor scores of deciduous species during fall and winter):

3	Healthy tree, with more than 75% of green, not wilted leaves. Also active growing points (apices) may be visible.
2	Affected tree, with 25-75% of the leaves being wilted, yellow or brown
1	Severely affected tree with less than 25% of the leaves being green (i.e. the majority wilted, yellow of brown)
0	Presumably dead tree with no or only wilted leaves. Trees, however, may still recover by resprouting after a rain event.

It is a very hard area to reach, on top of a mountain with no paved roads leading there. Especially in the rainy season it is almost impossible to get there. During the dry season someone is needed to go there on a horse, to manually count the number of survived vs dead trees that were planted.

Description

Partners

Land Life Company was on hand to help. Together with CONAFOR (Mexican Ministry of Forestry) and CONANP (Ministry of Protected Natural Areas), the local community and World Wildlife Fund (WWF), we kicked off the reforestation project in the first week of April 2016. By teaching the local farmers new planting techniques we hope to help restore 100 hectares of degraded forest land, adding to the Monarch's precious habitat.

Costs and financing

A grant was received from the Dutch Postcode lottery. Cost per ha was between $2000 - 3500.

Timetable

ACTION TIMETABLE		
2016	2017	2018
Planting of 7500 trees	Planting of 2500	Monitoring and expansion to restore whole site

Overall assessment

The first plantings with the Cocoon resulted in an average of 93% survival one year after planting, as opposed to 3-5% that was achieved in previous decades, proving that we can ensure the survival of this iconic species for the coming generations.

Moreover, the local population has set up 24/7 surveillance of the area to stop illegal logging, and there is more and more awareness of the issues that this causes.

STRONG POINTS	WEAK POINTS
- high survival rates - protection of endangered species - local employment and pride - ecotourism	- nylon wicks do not degrade fast

Perspectives

Continuation

The objective is to restore the entire monarch habitat. With EUR 3-5m, we can successfully restore the entire monarch habitat, ensuring the survival of this iconic species for the coming generations.

The company is working to get funding for follow-up projects to plant more trees and to educate the people about the importance of trees for the area and maybe convert it into an eco-tourism site.

Transposability

Globally, the Land Life Company has planted over 20 successful projects in the Middle East, USA, Mexico, South Africa, Spain and Australia.

➢ UNHCR – Re-greening and productive trees (fodder, medicine, fuel and food) planting in Minawao refugee camp in Northern Cameroon.

➢ UNICEF – Planting on an active mine site with UNICEF's Climate Ambassadors.

➢ ICBA, Dubai demonstration project. Testing of 3 native species for highway planting.

➢ Part of the "Un Nuevo Bosque" project in Mexico, revitalizing 3,500 hectares in a single day across all 35 states. Collaboration with CONAFOR, TV Azteca.

➢ European Union Greenlink project, restoring degraded ecosystems and planting productive trees (figs, pomegranate, nuts ao) in Greece, Italy and Spain by sustainably planting 30,000 trees with the Cocoon technology

➢ Highway restoration in California with Caltrans, reducing water use and improving survival rates for restoration of highway shoulders across the state

➢ Water conservation and ecosystem restoration of datacenter sites in California.

➢ Restoring UNESCO World Heritage site, the Galapagos islands with the Charles Darwin Foundation.

The Monarch Biosphere Reserve © The Land Life Company

Publications

http://magazine.landlifecompany.com/magnificent-monarch/

Realized by:

With the financial support of:

AGENCE FRANÇAISE POUR LA BIODIVERSITÉ
ÉTABLISSEMENT PUBLIC DE L'ÉTAT

and the technical support of the French Ecological Engineering Resource Centre:

Centre de ressources GÉNIE ÉCOLOGIQUE

Conservation and restoration of alluvial habitats of community interest on the Liberty Island and side channel

N°9

IN A NUTSHELL

Identity of the organisation

Organisation: WWF Hungary

Website: http://www.libertyisland.hu/index.php?l=_en

Contact: Laurice EREIFEJ – Head of WWF DCP Freshwater Programme - WWF Hungary. Tel.: + 36 1 214 5554 - laurice.ereifej@wwf.hu

Site identity

Site: Liberty (Szabadság) Island

Location: Close to city of Mohacs; part of Duna-Drava National Park, Béda-Karapancsa region

Specificities: Islands of the Danube and their side-arms are home to extraordinarily rich wildlife: all the species living in the side branches require milder waterflow compared to the main branch, warmer water, riparian vegetation and rambling hideouts.

Challenges: Many protected riverine fish species depend on the special hydraulic conditions of the side-arm in one or more phases of their life cycle (it is much more difficult to survive in the main branch for juveniles because of the tough conditions they would have to face there otherwise. The conservation of *Salicion albae alluvial forests* was also a challenge for this project

Legal status: Strictly protected and Natura 2000 site, and Habitat of community interest.

Areas: Woodland area, Aquatic environment (rivers)

Action type: Restoration or rehabilitation (towards the ecosystems historical trend or repairing key functions).

Action framework: Management of nature areas, Natura 2000, Blue and green corridors.

History and context

The Liberty Island is located in South-Hungary northward from Mohács at the left side of the Danube. Its length is about 3 km, its width is 150-200 meters, and its territory is 47 ha. The island and the side-arm belong to the Danube-Drava National Park and are part of the Natura 2000 network. The island is a strictly protected nature conservation area. Along the side branch, on the left side of the Danube, the local water service company has its bank filtered water wells to provide, among others, the drinking water for the settlements of South Baranya County. The island is covered by soft-wood alluvial forest.

Before the launch of the project, commercial forestry was going on, even in spite of the protected status. A weak environment policy in Hungary explains this situation. Consequently, hybrid poplar plantations and non-native, fast-growing invasive tree species threatened the habitat.

The 150 meter wide side branch was blocked by a rock-fill dam in 1982, splitting up the side-arm into two parts, stopping the natural river flow. This caused the accelerated filling up of the riverbed. Finally, it became a big mud pond with stagnant water, with flowing water only for some days per year. At the northern and southern end of the island, only two narrow trickles provided connection with the main branch. Waders were searching in the little puddles, but after they dried out, they found nothing there. The shallow puddles became ecological graveyard. It could be seen clearly at the millennium that something had to be done in order to avoid the merge of the island with the bank. The rock-fill dam was built for river regulation and navigation purposes, namely to sustain more water in the main river branch instead of in the side-arm during low water periods. Later, when the waterpipe connecting the left side wells with the right side water purification station were built, they were placed beneath the main course of the Danube in the riverbed but for some reasons they were placed into the rock-fill dam in the side-branch. So thus the dam reached the 6 meters height, which can be overflowed only by the highest floods and stopped the water flow in the 95% of the year.

Before the project – Source: WWF

- Socio-economic context

Local stakeholders and inhabitants used to take their recreation on the beach downstream of the island, but as a consequence of the changed water regime, the beach degraded. The local Rowing Association had to change its training routes because the siltation and the rock-fill dam restricted their possibilities. The bank-filtration drinking water wells along the Danube, next to the island, are also affected both in respect of quality and quantity.

Presentation of the project

Issues and objectives

Floodplains along the Danube river have suffered an 80% loss during the last 100 years, and the remaining area is also threatened by degrading factors. The project site is on the lower section of the Hungarian Danube stretch. Here the remaining tracts of semi-natural alluvial softwood forests within the actual floodplains are threatened by commercial forest management practices, by the spread of invasive species, by decreasing water supply and by the decline of habitat diversity due to river regulation.

The project aimed at mitigating the factors that threatened the *Salicion albae* alluvial forests on Liberty Island in order to improve the conservation status of this habitat of community interest. Main factors targeted were the spread of alien species (*Fraxinus pennsylvanica, Acer negundo)*, improper forest management practices and the accelerated silting-up process in the side-arm. The project objectives included the increase of the extension of forest associations composed of native species by transforming homogeneous patches of hybrid poplar; reducing the presence of invasive tree species under 20%; improving water availability for the riparian forests during low water periods by restoring the continuous water flow in the side branch; and raising of awareness on the importance and problems of alluvial forests.

The project also aimed at the dissemination of the 'ecosystem services' concept, in order to find common interest for the conservation of natural values and sustainable use of natural resources.

Expected longer term results were:

- The conservation status of the 47 ha alluvial softwood forests on the island will improve, as they are managed according to nature conservation goals by the Danube-Drava National Park Directorate.
- The ratio of invasive tree species will not increase as the closed natural forest ecosystem obstructs the re-growth and the germination.
- The longitudinal connectivity of the side branch is provided, it is self-sustaining as much as possible (in spite of the natural side-arm development and succession).

Human and material resources

Project management

The development of the LIFE-Nature project started thanks to a partnership, which aimed at saving Liberty Island, established with the participation of WWF Hungary, Mohács Municipality, Danube-Drava National Park, Lower Danube Valley Water Directorate (ADUVIZIG) and Transdanubian Regional *Waterworks* (DRV) in 2004, and to a cooperation agreement signed between WWF and The Coca-Cola Company, with focus on river restoration on the Danube in 2007.

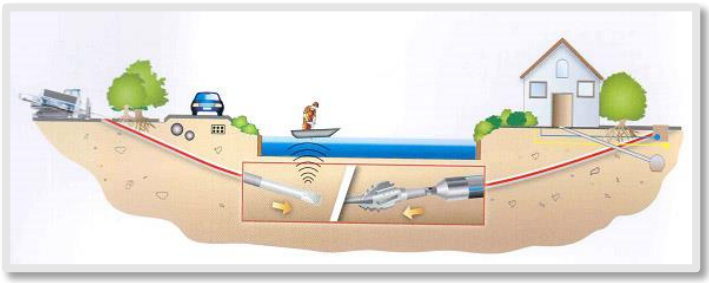
The LIFE-Nature project was submitted in 2007, it started in January 2009 and ended in December 2013. The project was coordinated by WWF Hungary, and was implemented with two state bodies (Danube-Drava National Park Directorate and Lower-Danube-valley Directorate for Water) and a state-owned company Transdanubian Regional Waterworks Co. The cooperation was based on the Partnership Agreement, signed in September 2009.

The project management was built up in a way to provide coherence among the different actions. Every action was dedicated to the responsibility of one of the partners. The coherence was ensured by the project coordinator, who was involved in the technical details of all actions. The personal motivation and engagement of the participants was achieved in the aim of the best results.

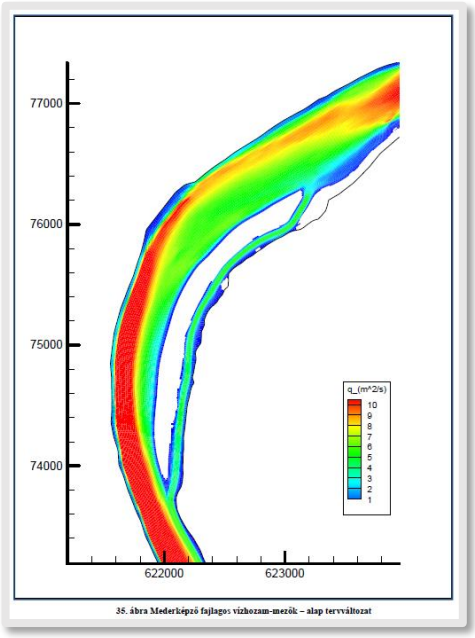
Harmonizing the different interests of different sectors that affect the active floodplain was a continuous challenge. However, on this project site all stakeholders (conservationists, local government and inhabitants, responsible water management body, the regional water supplier and other companies) were interested in implementing the restoration, and they cooperated in developing and implementing the project. All partners had some benefits from the implementation: restored side branch and floodplain forest (protected and Natura 2000) for the Danube-Drava National Park Directorate, better water supply conditions for the Waterworks Co., improving water management conditions and steps towards the implementation of the WFD for the Water Management Directorate, improving status of the priority river Danube for WWF Hungary, improved possibilities for recreation for the municipality of Mohacs. Strong Customer Service Representative position for the Coca-Cola Company that is a significant water user. This offered a unique opportunity to halt the degradation and improve the conservation status of the habitats, and create a demonstration site of a restored island-sidearm system on the floodplain.

Concerning material resources, heavy equipment was needed for hydro-technical works (dredging ships, excavators...). For the replacement of the waterpipes from the dam to under the ground, horizontal directional drilling (HDD) was used to create the tunnel for the new waterpipes under the side branch.

Hydraulic numerical modelling was used for the planning of the appropriate quantity of the silt to be dredged and of the best shape of the new riverbed to be self-sustained later and to provide sufficient water depth all around the year.



Horizontal Directional Drilling (HDD) – Source: WWF Hungary



Projected discharge at mid-water level after the restoration. Source: WWF Hungary

With the help of the modelling, it was defined to what extent the rock-fill dam could be demolished, and the future width of the dredged new bed, and the height of the remaining check dam was calculated. The dam was not completely removed because the maintenance of the proper water level for the navigation route was one of the conditions. This way the opening of the side branch did not cause any decrease in the low navigation water level.

Creation, restoration methods

The first step was the purchase of the entire area of the Liberty Island in March 2009, in the 3rd month of the project. Since then, it was a state-owned area managed by the Danube-Drava National Park Directorate, and dedicated exclusively for nature conservation. Danube-Drava National Park Directorate was officially registered as the forest manager of the 2 forest compartments of the project site.

The project covered large-scale hydro-technical works in the side-arm and professional forestry actions on the island, plus dissemination actions. Before beginning the field works the following plans were prepared and permissions were acquired: environmental permit based on the Environmental Impact Assessment of the complete project, revised Forest Management Plan that includes the planned conservation management actions, technical design and the corresponding water permit for the dredging, the water pipe relocation and the opening of the rock-fill dam, and execution plan for the hydro-technical works.

To receive all the necessary permissions needed longer time than it was expected. In case of the hydro technical works, to meet legal requirements, the preparatory phase of the project lasted about 3.5 years, while the field implementation took 1.5 years. In case of forest restoration, the preparations took 22 months, and the implementation could start at the very beginning of the 3rd year of the project period.

Forest conversion activities and elimination of invasive species

The 47 ha island is covered by alluvial softwood formations, corresponding to the habitat of community interest 91E0 (*Salicion albae* alluvial forests). The area was affected by invasive tree species (*Fraxinus pennsylvanica* and *Acer negundo*) and a hybrid poplar plantation of a size about 9 ha. Within the project, the Forest Management Plan was modified and included 'nature conservation' and 'Natura 2000' as the only purpose of the forest on the island. It also included the required conservation management: felling of non-native species and reforestation with native ones.

Field activities covered two type of activities: invasive clearance and forest conversion. The invasives were cut selectively on the entire island to decrease their proportion under 20% (proportion based on field experiences). As *Fraxinus pennsylvanica* and *Acer negundo* are dioecious, the focus was on the removal of the female trees to prevent speeding. The waste was sold for timber, the income was reported to LIFE and deducted from the LIFE grant. Under forest conversion the hybrid poplar plantation was converted to semi-natural alluvial forest. First the plantation was clear-cut on 2 sites of 2.5 ha and selectively cut on 4 ha. Then the area was fenced around for the prevention of game damage (deer, red deer, boar - in total 1 900 m fence was built). The fences are composed of 2 m high strained metal wire net supported by wooden poles. The area then was re-forested by regionally grown saplings of *Populus x canescens, Ulmus laevis* and *Fraxinus angustifolia ssp. pannonica* and *Pyrus piraster*. Two methods were tested on 2.5 ha each: i) 8,000 saplings were planted in 3 m row distance and nursed with machinery and ii) dense-row technology: 12,000 saplings were planted in 1.5 m row-distance and nursed by handwork. As sapling are very sensitive to groundwater level in the first years, a consequence of a draught and then a flood, the saplings died in spots and were replaced twice. On the additional 4 hectares 50 % of the old trees remained, and saplings were planted under the trees. The income originated from selling the timber was used within the project.

The Forest Management Permit was approved on 23 September 2010, the clear cut was done from February to April 2011, the fence was built in May-June 2011, and the planting was done in April 2011. The replacements were required in October 2012 and October 2013.

After 3 years, by the end of the project, there was a significant difference between the three areas where different methodologies were used. Traditional reforestation: the young trees were growing slowly, they were damaged by draught and flood, needed to be replaced sporadically. Dense-row technology: the samplings grew quite well, they were 5-7 m high and their canopy closure was over 70%. Felling 50 % and under-planting: trees developed slowly and also suffered from draught and flood. The difference between the 3 parts is not due only to the difference in the elevation, but to its combined effect with the different technology used. Dense-tow technology can be recommended, since it involves more costs and labour at the beginning but pays off within a few years by avoiding replacements.

Hydro-technical works

Hydro-technical works covered the ecological purpose dredging of the sediment, the opening of the rock-fill dam, and the relocation of the water pipes running in the dam. These works had to be synchronised and harmonised, timing of the different actions were critical.

Ecological purpose dredging

The cumulated sediment elevated the riverbed of the side-arm to a level that during low water periods it became partly dry. Dredging of it was essential to provide freeway for the water flow in low-water periods so that water supply for the riparian forests and habitat for the aquatic life could be ensured. The aim was to provide all-year-around water flow in the side-arm. Two main criteria were expressed towards the designer: i) to achieve reasonable deep water and water flow even in the lowest water level season, and ii) to have the most possible self-sustaining riverbed morphology and shape. The first part was the detailed survey of the original side-arm. Then using a computer model the designer simulated different versions of the designed stage. Finally, the best version was decided and the technical plan was finalised and submitted to the relevant authority for getting the water permission.

As the side-arm was considerably silted up, approximately one third of the width was dredged – this provides 30-50 m wide flowing side-arm. The work was done with two professional dredging ships. In total 160,000 m^3 sediment was removed and deposited safely into the main channel of the Danube, allowing to address a part of the riverbed deepening problem. The effect on the main channel of the sediment placed there will not be studied since, compared to the size of the main river, it was not a big amount. The side branch is monitored for the movement of the riverbed material.

Dredging. Source : WWF

The water permit was earned on 4 February 2011. The works were started in July 2012 and ended in March 2013. The company for the implementation was selected in a public procurement procedure.

Water pipe relocation

Work on water pipes – Source: WWF

In the rock-fill dam, which cut the side-arm in the middle, two water pipes were running. These connected the water wells on the left bank with the purification station of the water service company on the right bank. In order to be able to disassembly the dam they had to be re-located under the riverbed. The 3 available technologies were examined in a comparative study, and the horizontal directional drilling technology was selected. Its main advantage, beyond the price, is that minimal surface disturbance is needed. It is important in a nature conservation area.

The technical design was finished by October 2010, the water permit was issued in May 2012. The execution plan was finished in June 2012. The selection of the implementing company was completed between July and September 2012. The implementation works started on 24 September 2012 and finished in April 2013.

Opening of the rock-fill dam

After removing the old pipe sections, the partial demolishing and the opening of the rock-fill dam became possible. It was the last step of the hydro-technical works. The shape and size of the opening was in harmony with the dredged width of the side-arm. The height of the dam on the total width was equally decreased by 2 meters, and a further 4 m was removed in the middle in order to create a low-water riverbed. The machinery needed was a regular excavator. This deep opening has a trapezoid shape: it is 20 m wide in its bottom and getting wider upwards.

The disassembly of the dam was conducted between July and October 2013.

Communication and dissemination

Communication and dissemination activities targeted the general public and the expert communities. To the general public simple messages were disseminated about the wildlife diversity of floodplains and side-arms and about the works completed during the project. Media work were used to generate articles in on-line and printed media. 4 media events were organised, out of which 2 included field visits. Several voluntary days were organised on the site, and 3 public forums for local people.

The rock-fill dam – Source: WWF

The project has its own website at www.szabadsagsziget.hu and www.libertyisland.hu, both in Hungarian and English. It was regularly updated with news, project results and audio-visual material. Altogether more than 30,000 website visitors were registered.

The whole project was filmed, and in the end, different length versions of the project film for different target groups were produced (some of them also in English). They are available on-line through the website and on Youtube and the TV version was broadcast by national channels.

Along the restored side-arm a fluvial nature trail was created, which can be visited by boat or canoe.

There was no systematic survey among the local people of Mohács about the knowledge and acceptance of the project, however during the forums and other events interest was high, and their attitude was positive.

In order to inform the expert community of the different professional fields, the staff of WWF presented the project results at several conferences and workshops during the five years. Two workshops were held on the project site, one for Hungarian and one for foreign conservation experts. In the last year of the project an international

closing conference in Mohács was organised with over 90 participants from 5 countries, to present project results, enhance experience exchange and gain new inspiration.

Monitoring and evaluation methods

The results of the conservation actions were followed by aquatic and terrestrial monitoring. It registered the base-line data before the interventions started, and then sampled the site in 2012 and 2013. As the field work was finished in 2013, in order to get information on the real impact of the project further monitoring will be needed after some years.

Description

Facilitation

The project partners had regular meetings, the lead partner had to give strong guidance for that. The inhabitants of the city of Mohacs were informed about the project progress two times during the implementation.

Regular reports were sent to the Commission (progress reports, midterm reports and final reports). After the LIFE-Nature, the second biggest grant as provided by Coca-Cola Hungary but they didn't require formal reporting. Regular information on the progress were provided to the contact person of Coca-Cola Hungary, and the management and a group of staff were invited to the island during the project.

Partners

The main partners were:

-WWF Hungary – Coordinator of the project. It was the main beneficiary, and was responsible for the coordination, communication and the ecological purpose dredging of the silted-up sediments from the side channel.

-Duna-Dráva National Park Directorate - As part of the forest management it was responsible for the transformation of hybrid poplar plantations into forests composed of native species, and the reduction of invasively spreading tree species in the project area. Apart from the forestry management it was the responsible beneficiary for purchasing the island, the conservation management and the monitoring.

-Lower-Danube-valley Water Management Directorate - Responsible for the opening of the rock-fill dam.

-Transdanubian Regional Waterworks Public Company - Responsible for the relocation of the hydraulical delivery pipes under the riverbed.

The project was co-financed by Coca-Cola Hungary (Coca-Cola HBC Magyarország Kft., Coca-Cola Services Magyarország Kft.) and the Municipality of Mohács Town.

Costs and financing

Total budget: 1 795 529 €. Eligible costs: 1 434 529 €.

EU co-financing: 1 075 896 €, 75% of eligible costs, approx. 60% of total budget, due to infrastructure element

Financial summary

The spending was in line with the original budget, overspending and underspending of cost categories were justified and they stayed within the defined limits by LIFE regulation.

The relocation of the water pipe was eligible only in part, since it was a large infrastructure element. This non-eligible item was less expensive than estimated in the original budget, due to the innovative HDD technology.

The project was implemented by 4 different organisations as beneficiaries. They provided their own contribution. The risk of exchange rate changes was borne by the coordinated beneficiary. At the end, its effect was positive and it helped to keep within the planned project budget. The Financial Report was compiled by merging the internal financial progress reports, prepared by each beneficiary.

The respective costs of the different actions were as follows:

- 46% dredging
- 22,6% waterpipe relocation
- 9% buying the island
- 6,5% forestry works
- 4,4% environmental impact assessment and monitoring
- 3,2% communication
- 2,8% opening the rock-fill dam (after waterpipe relocation)
- 5,4% project management.

Timetable

ACTION TIMETABLE

2009	2010	2011	2012	2013
-Partnership agreement -Purchasing of the entire area of the Liberty Island in March 2009 -Environmental Impact Assessment -Forest management planning	-Water pipe relocation : technical design finished by October 2010 -Hydraulical modelling and technical design of dredging and dam opening	Clearing of invasive species: from February to April 2011. -Forest conversion: the fence was built in May-June 2011, and the planting was done in April 2011	-Water pipe relocation: the water permit was issued in May 2012. The execution plan was finished in June 2012. The implementation works started on 24 September 2012 -Dredging works: started in July 2012 -Forest conversion: replacement in October 2012	Dredging works ended in March 2013 -Water pipe relocation : end of the implementation works in April 2013 -Disassembling of the dam between July and October 2013 -Forest conversion: replacement in October 2013 -Dissemination of the project results

Duration: 01.01.2009 – 31.12.2013, 60 months

Overall assessment

Achievements

As a result of this project, the Liberty Island and its side-arm have been transformed to a relatively undisturbed floodplain ecosystem, where natural processes can be dominant again. The entire island is dedicated exclusively to nature conservation purposes, and its long-term

preservation is ensured. Commercial forestry was stopped and only conservation management can take place on the site. The forests of the island have been started to grow into a semi-natural alluvial softwood forest with less than 20% of invasive tree species presence. According to monitoring, the re-forestation develops well.

Replanted native forest after 4 years (with project manager of WWF, Viktória Siposs) – Source: WWF Hungary

The Danube side-arm is re-vitalised, it is providing appropriate water supply for the alluvial forest on its banks. Free water flow is ensured the whole year round, thus the specific habitats of parapotamal (dead arms retaining a connection to the main channel) side-arms can form. Hydraulic monitoring in the side-branch is necessary to assess sedimentation balance. The minimum water level for navigation purposes in the main river course is ensured and the re-opening of the side-branch didn't affect negatively the navigation conditions. The authority that is responsible for the navigation route approved the new status. Additionally, the project applied and disseminated the 'ecosystem services' principle, since is it expected that the restoration of the side-arm will improve the quantity and quality of the water extracted through the bank-filtered water wells of the regional water providing company.

After the project – Source: WWF Hungary

Key outputs and deliverables

- Partnership Agreements signed

- 47 ha Natura 2000 area bought, forest under National Park management

- Environmental Impact Assessment produced and environmental permit acquired

- Technical design for the dredging, opening of the dam and water pipe relocation

Opportunities offered by the Liberty Island – Source: WWF Hungary

- Water permit for all hydro-technical works

- Execution plans for the hydro-technical works

- 160,000 m^3 sediment removed from the side-arm

- 2 water pipes relocated under the riverbed

- 6000 m^3 stones removed from the dam, the barrier to the continuous water flow eliminated

- Forest Management Plan appropriately modified and approved by the authority

- 9 ha forest converted into native softwood forest type

- 3 reforestation methods tested

- Invasive tree species controlled, its coverage reduced on 47 ha

- Monitoring reports of terrestrial and aquatic monitoring

- 2 large size bilingual information boards erected on the project site and in Mohács

- 3 forums held for local stakeholders with high interest

- 10,000 pieces of starting leaflet issued (in Hungarian and English)

- 1000 pieces of low value promotional objects produced and distributed

Beavers are also happy – Source: WWF Hungary

- Project website in 2 languages, with more than 30,000 visitors

- 4 media events and 11+ press releases, which generated more than 300 clippings

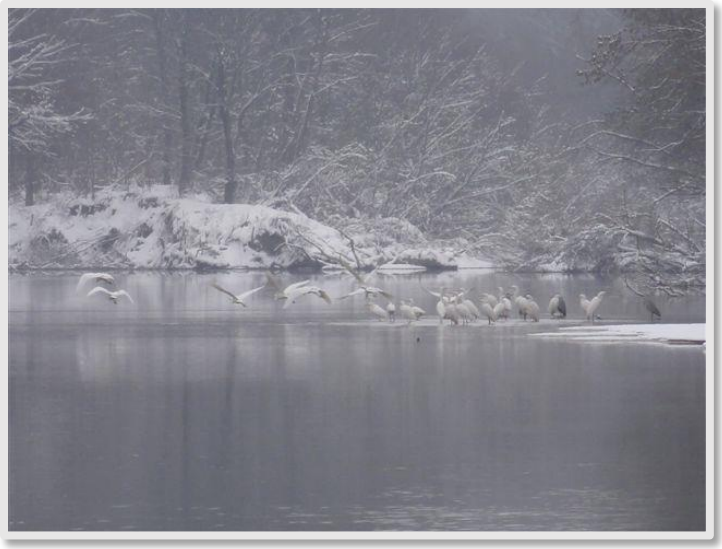
- 2 workshops and 1 international conference organised for scientific experience exchange

- A summary of the scientific conference issued as an electronic publication

- 5-stops long nature study trail was constructed along the banks of the side-arm

- 5 project films were produced, 3 of them with English version (published on-line and on DVD, 150 pieces)

- After-LIFE Conservation Plan compiled and signed by the Partners.



Wintering birds after restoration – Source: WWF Hungary

IMPROVEMENTS - ADVISES

— The LIFE programme grants cover only 55-75% of nature conversation projects. Therefore the main challenge for any project owner is to find the funding to cover the rest of the budget. The scale of the intervention implies that nor are the interested local municipalities, nor other stakeholders able to cover it themselves. In this case the interest and involvement of Coca-Cola Hungary was the key besides the contribution of all the other partners.

Perspectives

Continuation

The project is finished, but an After-LIFE Conservation Plan was signed by the Partners. The ecological and hydraulic monitoring was restarted in 2018.

The National Park Directorate is the trustee of the island and it takes care of it through its regular ranger system. Rangers look after the island, collect data and report any problem detected. Nursing of the young forest was continued for some years, until it was necessary, and the monitoring of the invasive species is on-going to see whether intervention is necessary. However, on the long run non-intervention management of the forest is planned. The island become one of the destinations where the rangers provide guided tours within the DDNP.

Transposability

However, this was a special project with the partnership of NGO, state owned directorates, municipality and drinking water supply company, there is huge potential for the reconnection of side-branches to the Danube on the whole Hungarian Danube. The experiences of Liberty Island project can be replicable in any upcoming restoration works.

Publications

-Layman's Report http://www.szabadsagsziget.hu/media/1387292425_wwf_laymans_report_kesz_kicsi.pdf

-Summary and presentation of the closing conference http://www.szabadsagsziget.hu/index.php?m=informaciok/4/akcio_d3_szakmai_tapasztalatcsere

Realized by:

International Office for Water

With the financial support of:

AGENCE FRANÇAISE POUR LA BIODIVERSITÉ
ÉTABLISSEMENT PUBLIC DE L'ÉTAT

and the technical support of the French Ecological Engineering Resource Centre:

Centre de ressources GÉNIE ÉCOLOGIQUE

LIFE ENEBRO : Restoration of Coastal Dunes with *Juniperus spp*. in Valencia

N°10

IN A NUTSHELL

Identity of the organisation

Organisation: Devesa-Albufera service. City Council of Valencia.

Websites:
http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=2625&docType=pdf

http://albufera.valencia.es/

Contact: Sandra Pérez Manjón, SERVICI DEVESA-ALBUFERA sperezma@valencia.es

Site identity

Name of the site and localisation: The Albufera de Valencia Natural Park. The Albufera is located just 10 kilometers from the Valencia city centre, on the Mediterranean coast, in Spain.

Specificities: The Devesa de l'Albufera de Valencia is a narrow coastal strip of sand, that is part of the restinga (a restinga is a sandy and salty ground, which sequesters a portion of the sea between it and the mainland, and is covered with characteristic herbaceous plants (Wikipedia)) that closed the Gulf of Valencia, converting it into a lagoon. The area is of alluvial origin (quaternary) and covers an area of 850 ha. It combines a series of varied climatic and edaphic factors, which provide a diversity of ecosystems of great value, among which we differentiate, the outer dune ridge; the interior stabilized dunes and the interdune depressions, which are locally called "malladas". In the 1970s, the urban development altered the area and the ecosystems.

Challenges: The sea juniper, *Juniperus oxycedrus subsp. Macrocarpa* is the most representative plant species on stabilised dunes and pre-forest vegetation. However its habitat is threatened in the Albufera de Valencia, because of urban development and infrastructure. The project aims at restoring its habitat: 2250 - Coastal dunes with *Juniperus spp* (priority)

Legal status: The "natural park" status for the Albufera de Valencia was obtained in 1986. The area is a Natura 2000 site. The area is listed under the Ramsar Conventio

Areas: coastal environment

Action type: restoration or rehabilitation, species reintroduction, translocation

Action framework: management of nature areas, Natura 2000

History and context

The Albufera de Valencia Natural Park is located on the eastern Mediterranean coast of the Iberian Peninsula. With chains of shifting and stabilised dunes, it is a natural barrier between a shallow lagoon and the adjacent sea. The structure of the Devesa is as follows:

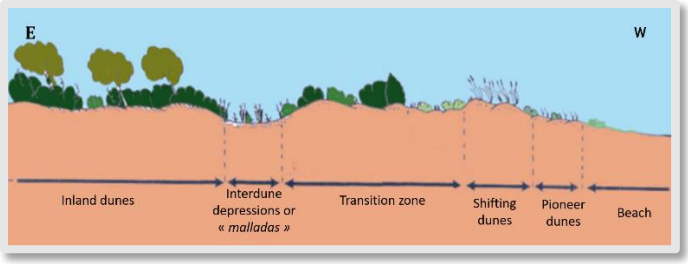
- The beach (with three sub-ecosystems: the submerged beach, the wet beach and the dry beach)

Simplification of the ecosystem profile of the Devesa. © Olmos et al.

- The outer dune ridge: it is the closest area to the beach. It is the first front of dunes, the dunes are parallel to the sea. Because of wind effects, abrasion craters are formed. The vegetation and the fauna adopt special strategies to face the harsh environmental conditions of this ecosystem. As we move away from the sea, sub-shrub plant species are more abundant and species typical of the coastal maquis begin to appear.

- The interdune depressions are characterized by silty soils. The vegetation is installed in concentric rings depending on the degree of salinity. In the central part, where the level of salt is very high, no vegetation appears. Around of this area is the salting vegetation, formed mainly by salicornias, and in the most external part, the juncales and grasslands are installed.

- The interior dune system is characterized by the oldest dunes, where the plant cover is much denser.



The most representative plant species on stabilised dunes and pre-forest vegetation is the sea juniper, *Juniperus oxycedrus subsp. macrocarpa.* Sea juniper is a small evergreen tree, of very slow growing and with great longevity. It appears in dunes and sandy areas in the Mediterranean cost. Junipers are dioecious, i.e. individual juniper trees are either male or female.

Juniperus macrocarpa (large-fruited juniper, syn. J. oxycedrus subsp. Macrocarpa) ©Wikipédia.

At the end of the 60s, during the touristic boom, an urbanization process began in La Devesa which seriously altered its ecosystems (the same situation occurred throughout the Mediterranean coast). The outer dune ridge was totally destroyed to build a boardwalk. The interdune depressions were filled with sand coming from those front dunes and repopulated with eucalyptus. The interior dune alignment was fragmented with the construction of roads, buildings, sanitation and electrical infrastructures.

The habitat of the sea juniper has been altered. Some of the negative effects of the urban development that affected the site have been reversed thanks to a previous LIFE Nature project (LIFE00NAT/E/007339) on the site. But action was still needed to help recover the

second chain of sand dunes, reverse the degradation of plant formations and reintroduce important habitat features, such as temporary pools.

The LIFE ENEBRO project tackled the following problems:

- The alteration of the geomorphology of the dunes

- The lack of marine juniper specimens. The population of marine juniper only had 30 natural specimens and 305 planted ones. Also, there were few female juniper plants and some were quite far away from the male plants making natural pollinisation, fruiting and germination difficult.

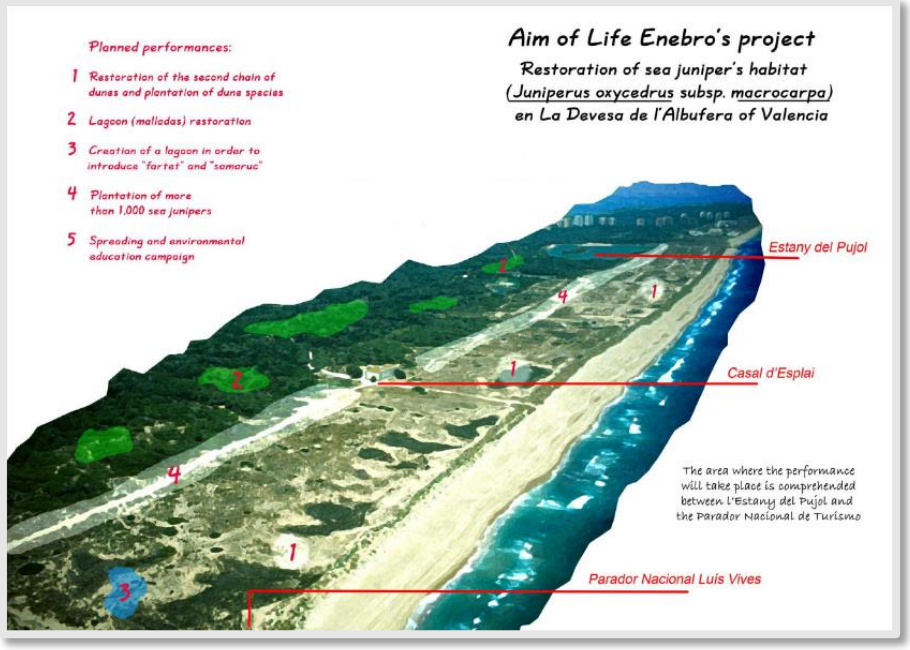
- The annual germination and production of marine juniper is very low in the Municipal Nurseries in El Saler. Thus, the reintroduction of sea Juniper is a very slow process.

- There was lack of technical information about sea Juniper and its habitat among the local population.

Presentation of the project

Issues and objectives

The aim of the project was to recover 55 hectares of sand dunes, reintroducing a viable population of sea juniper in La Devesa de l'Albufera de Valencia. The project also aimed to restore a large network of temporary ponds and reintroduce two fish species. In addition, an awareness raising campaign aimed to change attitudes among locals and tourists towards the preservation of these habitats.



Brochure © Ayto Valencia.

Creation, restoration methods:

The methodology used has considered four lines of action, one for each of the problems listed above.

- Reconstruction of the dune geomorphology:

The semi-fixed dunes were restored by reconstructing dune hills with the sand coming from the excavation of the malladas (interdune depressions) and abrasion platforms were re-created. The recovery of a network of malladas allowed new hydro-halophilous vegetation and aquatic fauna to establish.

To design the new morphology of the dunes, a comparative analysis has been carried out between two cartographies (of 1965 and 2001) to quantify and detect the changes which took place between both dates. As a result of the comparison, a map of changes was established, showing in different colours the decreases in height and the increments. The decreases correspond mainly to old dunes that have disappeared and the increments correspond to abrasion craters that have been filled. Fieldwork onsite allowed to recognize the convenience or not of the location and design of the new defined elements. Some modifications were needed, because, for example, it was senseless to create a dune where there was an abrasion crater at the time of the visit (and vice versa).

In the south of the Devesa (Gola de El Puyol – Gola de El Perellonet), all the restoration of the dunes used the sand coming from the Devesa (from the malladas and abrasion craters). In the North part of the Devesa, sand coming from outside has been used, because there was not enough sand on-site. The sand was dredged from the sea bottom at the north of the port and was transported by boat to La Devesa or it was brought by trucks, from the dry beach located at north of the port. To avoid the spread of invasive species coming from the sand, the vegetation such as carpobrotus acinaciformis was manually removed.

Palisades were constructed to retain the sand accumulated on one side and on the other side, to capture the new sand, coming with the wind. Cana (*Arundo Donax*) spartina (*Spartina Versicolor*) were used to build the palisades. The permeability of the palisades to the wind was 40 – 50 %. The height of the palisades was 50 – 80cm. A particular attention was paid to the cane used to build the palisades and buried in the sand. They had to be dry (and not green) to prevent them from sprouting and invading the dune.

- Production of seedlings in the Municipal Nurseries of El Saler:

The plants needed to repopulate these 55 hectares have been produced using the seeds collected in La Devesa. Thus the local genetic diversity was maintained.

The production of sea juniper is based on direct autumnal sowings on tables of culture, stratified at room temperature and maintained for at least three years. However, germinations obtained in this way have always been scarce, and generally inferior to 5%. Different tests have been done in order to find some process that could increase the number of germinations. Enough juniper specimens were produced for reintroduction.

- Restoration of the vegetation cover in the area:

The objective of the project was to create the suitable conditions so that sea juniper can establish an autonomous population. Thus, plantations have been carried out after regenerating the dune geomorphology, so that sea juniper could survive. All the sea junipers have been planted in January and February 2008.

The new dunes were planted with the species produced in the Nurseries. A specific set of plants was assigned to each sector of the dune. To know in which zones the sea

juniper should be planted, an innovative and effective computerised "Predictive model" has been developed using photo-interpretation of photos from 1965. This technology helps to increase the survival rate of the vegetation regenerated and to accelerate the recovery of habitat features.

To ensure a successful planting, conclusions from past planting experiences in the zone have been taken into account. For example, between 1999 and 2000, a plantation of individuals was made, organized by age groups with individuals of one, two and three or more years old. Finally, the junipers who were 3 years old were those with the greater survival rate (approximately 80%), whereas the survival rate was 60% for those who were 2 years old, and 30% for those who were 1 year old. In the conditions of the Devesa, junipers of three years old were planted, although the use of plants of a certain age may pose some problems such as infection with fungi in the Nursery.

- Awareness and dissemination:

Website in several languages, press, television, leaflets, video, virtual seminars, conferences and information campaigns have been implemented to inform the population about the project.

Besides, permanent lagoon was created and two fish species were introduced there:

- Fartet (Spanish toothcarp - *Apahnius iberus*)

- Samaruc (Valencia toothcarp - *Valencia hispanica*).

These species are listed in the Annex II of the Habitats Directive.

The photos below come from the document "*La Devesa de l'albufera de valencia: un caso de restauración dunar*".

2002: Malladeta north and Brava beaches. Mallada de la Mata del Fang. Extracting sand and creating lagoon with permanent water, during the LIFE DUNA project.

2009: Beach of the South Malladeta. Detail of the lagoon made in the transition zone, exaggerating an abrasion crater ("caldera de abrasion). Introduction of two endemic fish species, the fartet (Aphanius iberus) and the samaruc (Valencia hispanica), during the LIFE ENEBRO project.

2003: During the LIFE DUNA project: Malladeta north and Brava beaches. The boardwalk has been removed and replaced by a dune system/cord. This has been set back 5m inland with respect to the boardwalk. The roads and car parks have been eliminated.

2008. During the LIFE ENEBRO project: North Malladeta and Brava beaches. The dunes with palisades stand out, recently repopulated with vegetation, and the craters from which part of the sand has been extracted. The first front dune is completely restored.

2010 : North Malladeta and Brava beaches. The restoration is finished. The first front dune was executed during the LIFE DUNA project and the transition zone during the LIFE ENEBRO project.

Human and material resources

To recover the geomorphology of the dunes, cartography and orthophotography of the year 1965 and of the year 2001, both to scale 1/2000, of the Service Devesa-Albufera of the City council have been used. Another geo-referenced orthophotograph of February 2003, provided by the Confederation Hydrographic of the Jucar, was also used.

Monitoring and evaluation methods

The Valencia City Council staff monitored the area after the end of the project. The survival of the plantations, the evolution of the dunes geomorphology were monitored.

In addition, the dissemination tasks and environmental education continued after the end of the project.

Description

The project started in October 2004 and ended in June 2008.

Partners

Technical partners: Technical office Devesa-Albufera service of the Valencia City Council

Financial partners: European Commission, Valencia City Council

Costs and financing

Total cost: 3 278 216€

EU contribution: 1 639 108 €

Valencia City Council contribution: 1 639 108 €.

Overall assessment

548.895 m2 of coastal dunes were created along with 69.077 m2 of malladas (interdune depressions). The following habitats listed in Annex I of the Habitats Directive were recovered:

- Coastal dunes with *Juniperus spp* (priority) on 216.000 m2 (n°2250)

- Mediterranean salt meadows (*Juncetalia maritimi*) (n°1410), Mediterranean and thermo-Atlantic halophilous

scrubs (*Sarcocornetea fruticosi*) (n°1420), Halo-nitrophilous scrubs (*Pegano-Salsoletea*) (n°1430) on 73.077 m2.

46,061 seedlings of 13 different plants have been produced in the Municipal Nurseries of El Saler and introduced in the area.

The project helped to fix and repopulate the new modelled line of dunes and a total of 288 m3 of coastal grass (*Spartina versicolor*) was sown during the project. Some 8 959 vegetation specimens and 18 vegetation species of interest were recovered.

Furthermore, 912 specimens of sea juniper were planted to reinforce the local population (92 female specimens, 384 male specimens and 436 indeterminate specimens).

Significant improvements in the germination rates for sea juniper were demonstrated during the project. The rates increased from 7% to 50%. This has had a major positive impact on the availability of juniper plants and associated ability to repopulate the area in future years.

An estimated 150 m3 of alien species (*Carpobrotus acinaciformis* and *Agave Americana*) were manually removed.

In addition to the vegetation work, the project created a permanent lagoon (4000m^2) which was designed to support self-sufficient populations of Fartet and Samaruc. Monitoring indicates that the 300 fishes which were released into the lagoon have survived well and are growing in numbers.

A variety of awareness raising and networking activities were undertaken (website, leaflet, press, video, virtual seminars, etc.) including 94 guided tours of the project area, which attracted interest and participation from 3 751 people

IMPROVEMENTS - ADVISES

Regarding the plantation of sea juniper:
- The most suitable period for planting is autumn, because the rain and the mild winter temperatures of the coastal areas allow to maximize the development of root systems before summer (and drought) comes.
- It is better to bury a part of the stem and the lower branches, because junipers are adapted to be partially covered by sand and if the roots are deeper, evapotranspiration is reduced, which increases the availability of water for the plant and can increase survival.
- It is recommended to repopulate the junipers in groups of five or more seedlings and within a 15 meter radius. The object of this measure is to plant specimens of both sexes in close proximity.

Other advices can be read in the document "Memoria de las jornadas virtuales PROYECTO LIFE ENEBRO".

Perspectives

Transposability

All the parts of the project can be replicated not only in the areas of the Spanish coast but also anywhere in the world. La Devesa is a peculiar place, because of its past, its high ecological value and its proximity to a large number of towns such as Valencia, El Saler, etc. The challenge was to combine ecological conservation and recreational use. The methods used in both LIFE project (Life Dune and Life Enebro) car be applied to solve similar problems in other parts of the world. The methodology can be exported to perform the following actions for example: recovery of the dune geomorphology, reconstruction of dune fills, abrasion craters and malladas, fixation of recovered dune hills, collection, conservation production and planting with native vegetation, etc.

Publications

Publication: Case study Title: "La Restauración de las Dunas Litorales de la Devesa de L'Albufera de Valencia" (2.7 MB) Author: Joan Miquel Benavent Olmos et al. No of pages: 34

Publication: Layman report Title: Layman report (ES/EN) Year: 2007 No of pages: 9

"Memoria de las jornadas virtuales PROYECTO LIFE ENEBRO".

Realized by: International Office for Water

With the financial support of: AGENCE FRANÇAISE POUR LA BIODIVERSITÉ ÉTABLISSEMENT PUBLIC DE L'ÉTAT

and the technical support of the French Ecological Engineering Resource Centre: Centre de ressources GÉNIE ÉCOLOGIQUE

Office International de l'Eau

15 rue Edouard Chamberland

87065 Limoges Cedex

Tel. (33) 5 55 11 47 80

www.oieau.org

With the financial support of

AGENCE FRANÇAISE POUR LA BIODIVERSITÉ

ÉTABLISSEMENT PUBLIC DE L'ÉTAT

www.afbiodiversite.fr