Institution: University of Leicester

Unit of Assessment: UoA5 Biological Science

Title of case study: Restoring the ecosystem services of Lake Naivasha (Kenya) for globally-important exports, unique biodiversity and 3/4 million people.

1. Summary of the impact

The Lake Naivasha region is a globally-important wildlife sanctuary, international tourism destination and the world's centre for cut flower export. Professor David Harper has led sustained ecological research over a number of years, and this has led to significant impact in terms of helping to resolve massive ecological degradation at Kenya's Lake Naivasha. The research has inspired the creation of a Lake management agency through involvement of HRH Prince of Wales – 'Imarisha' – and which incorporated Leicester's recommendations into its Sustainable Development Action Plan (2012-17), in turn underpinning increasing sales of Fair Trade products and ensuring the sustainability of Naivasha's ecosystem services for future generations.

2. Underpinning research

Background to the problem

The Lake Naivasha region is the economic and ecological jewel of Kenya. Its waters for irrigation make it a world centre for exporting cut flowers and for vegetables. It accounts for 70% of Kenya's flower exports, with a value of £260M p.a. and its exports constitute 40% of the EU's supermarket trade in cut flowers. Additionally the export of vegetables from the region accounts for 20% of Kenya's vegetable exports, worth £25M p.a. Together these account for 10% of Kenya's entire total foreign exchange revenue (see evidence **A**).

The Lake's high biodiversity, supporting over 350 bird species and more than 1,200 hippopotami, together with the related Ramsar Convention Wetland and Important Bird Area makes it a major centre for tourism, with some 1.8M tourists per annum bringing additional revenue to the country. Lastly the waters from the Lake also sustain Africa's first geothermal power station, which supplies just under a third of Kenya's electricity. In short, the Lake and its region are vastly important to the country's economy.

Research led by Harper and colleagues demonstrated that sustained degradation of Naivasha's ecosystem by the early 2000s, driven by the introduction of invasive exotic species and agricultural irrigation, critically threatened the future of the industry and the health and livelihoods of the (then) half a million people living around the Lake (3.1, 3.4).

The research clearly demonstrated

(a) what the causes of degradation were;
(b) that deterioration was rapid, and
(c) that the lake would cease delivering its services to communities - directly or indirectly - within 5 years (3.2).

Leicester-led research underpinning impact

Research on the lake ecosystem by Harper's team provided both a detailed understanding of the interacting causes of ecological degradation and innovative solutions to restore it. Rather than looking at individual aspects of the issue, they studied the dynamics of the whole ecosystem and identified how these multiple, interactive changes combined to cause the degradation (3.4, 3.5). For example, they identified that the Lake has been significantly impacted by the introduction of more than 10 alien species – including Louisiana crayfish, common carp and water hyacinth – which had dramatically damaged the food web structure (3.2) and ecosystem functioning.

In addition, humans (farmers, industries and domestic suppliers) affected the lake directly through over-abstraction of water and erosion of soils, bringing nutrients and turbidity (3.1). Naivasha's

resultant unstable state severely reduced its useable services to humans; the reduction of water level led to severe loss of papyrus which formerly offered protection from incoming storm waters and loss of ecosystem health through declines in wildlife populations (3.3).

Harper coordinated Leicester colleagues & students (see below). The team also included specialist researchers from elsewhere, to facilitate the multi-disciplinary approach required to understand the complex ecological problems, including:-

- R Britton (Environment Agency/Bournemouth University) and J Grey (Max Plank/QML) - combined stable isotope analyses with conventional methods to establish the 'keystone species' role of introduced species (3.5, 3.6).
- F. Gherardi (Florence, Italy) brought experience of alien species from southern Europe to help understand the impact of crayfish and predict future trends (3.5).
- N. Pacini (Calabria, Italy & Leicester PhD 2003) provided chemical analyses of lake water and plant material (3.5)

3. References to the research

Leicester scientists are in bold; all other scientists (except 3.1) are were funded for fieldwork from Harper's grants

3.1. Becht, R., **Harper, D.M**. (2002) towards and understanding of human impact upon the hydrology of Lake Naivasha, Kenya. *Hydrobiologia* **488**: 1-11

3.2. **Harper D.M, Smart, A.C., Coley, S**., Schmitz, S., North, R., Adams, C., Obade, P. & Kamau, M. (2002a). Distribution and abundance of the Louisiana red swamp crayfish *Procambarus clarkii* Girard at Lake Naivasha, Kenya between 1987 and 1999. *Hydrobiologia* **488,** 143-151.

3.3. **Harper D.M., Harper, M.M., Virani, M.A., Smart, A.C., Childress, R.B.,** Adatia, R., **Henderson, I.** & Chege B. (2002b). Population fluctuations and their causes in the African Fish Eagle, (*Haliaeetus vocifer* (Daudin)) at Lake Naivasha, Kenya. *Hydrobiologia* **488**, 171-180.

3.4. **Harper, D.M., Morrison, E.H.J., Macharia, M.M**., Mavuti, K.M. & **Upton, C** (2011) Lake Naivasha, Kenya: ecology, society and future. *Freshwater Reviews* **4**, 89-114

3.5. Gherardi, F., Britton, J. R., Mavuti, K. M., **Pacini, N.,** Grey, J., Tricarico, E., **Harper, D. M**. (2011) Allodiversity in Lake Naivasha, Kenya: developing conservation actions to protect East African lakes from alien species impacts. *Biological Conservation*, **144** 2585-2596.

3.6. Britton, JR., Boar, R., Grey, J., Foster, J., Lugonzo, J., & **Harper, D.M**. (2007). From introduction to fishery dominance: the initial impacts of the invasive carp *Cyprinus carpio* in Lake Naivasha, Kenya, 1999-2006. *Journal of Fish Biology*, **71**, 239-257.

The research (including 5 PhD students) was funded by grants to Harper from The EarthWatch Institute (over £1M, 1993-2007), British Council (£20K 2007-10), Darwin Initiative (£150K, 2007-10) NERC-ESPA (£20K; 2010-12) and 2 EU supermarkets (£0.5M, 2010-12).

4. Details of the impact

The agriculture, tourism and associated international income derived by Kenya from the Lake Naivasha region are critical for the future development of the country (**A**). Harper's research was pivotal in detecting this emerging ecological disaster and providing the evidence needed by other bodies to allow them to become involved in the restoration and development efforts. In addition, his work suggested solutions, and indicated how to monitor success, thus underpinning the activity that is restoring the Naivasha ecosystem for ecological and human benefit.

A spokesperson from the Lake Naivsha Riparian Association commented "*.. when Professor Harper began to write and speak publically in the mid 2000s about the lake's degraded state and make dire predictions about its future, everybody listened to what he was saying, including the government and the horticultural industry. His voice was not the only one calling for action by 2009, but it was the only one based on a scientific evaluation of the causes of degradation and with*

realistic proposals for how to reverse this state." (**B**)

Raising local, national & international awareness of Naivasha's ecological degradation.

Harper first raised public concern in 2005 through extensive media engagement on the Lake's deteriorating ecosystem and has continued these efforts since then. In 2009, for example, he was invited to address the consortium of EU retailer cut-flower buyers ('Coopernic') in Kenya, Frankfurt, Brussels and Vienna on the ecosystem's deterioration – to propose mechanisms to allow supermarkets to sponsor practical restoration activities at the Lake. As a result of these addresses and associated conversations, substantial funding (£500K) was raised from 2 Coopernic members for the restoration of critical lake margin habitats and projects promoting sustainable water use, water education and purifying surface water supplies by ecological methods for rural communities (**C,D**). WWF-UK began funding initiatives to protect the lake in July 2011, building on support WWF-Netherlands had provided since 2007, assisting businesses and people to protect Lake habitats and species, while still meeting their own needs (**E**).

Development of the Imarisha Naivasha Trust ('Imarisha' = 'arise' in Swahili)

As a result of the public concern raised by Harper's work, the Prince of Wales and the Kenyan Prime Minister discussed the Lake's state at a climate change conference in early 2010, resulting in a visit to Lake Naivasha by representatives of the Prince's International Sustainability Unit for discussions with the Kenyan Government and local people (**B,F**). Harper advised ISU staff for the visit and assisted with the development of ISU's subsequent report, which led directly to the establishment of an organisation – the *Imarisha Naivasha Trust* – (Gazette Notice No. 5368 20th May 2011) by the Prime Minister (**G**).

Harper has continued to assist Imarisha in formulating the organisation's structure and plans, leading to the 5-year Sustainable Development Action Plan in 2012 and the more broadly based Lake Naivasha Integrated Management Plan 2012-22 (IMP; **H,I**). *Imarisha Naivasha* has since raised over £1M for its continuing work from retailers (such as Asda, Sainsburys, Tesco and M&S, Finlays Horticulture Kenya, REWE and COOP) and the UK, Dutch and Swedish governments and charities such as WWF. Harper is currently Hon Secretary to Imarisha Trust's Research & Monitoring Technical Committee (**G**) and has been commissioned to deliver a summary report and a database of existing knowledge covering the major initial milestones of the SDAP.

Addressing the issues

The SDAP and IMP aim to address the issues facing Lake Naivasha and develop sustainable water-use activities such as tree planting and restoration of the papyrus beds which play a crucial role in water filtration and purification. For example, Finlays Horticulture Kenya and its customer German retailer REWE are funding a project to investigate the water cleaning effects of papyrus when planted on floating islands made of recycled post-consumer plastics, such as bottled water containers, made by a company called "Floating Islands International" (**J**). Other initiatives include the use of water hyacinth, a problematic invasive species, for handicrafts such as baskets; this would bring income from sales of goods as well as easing pressure on the lake, as well as the use of papyrus for charcoal to ease pressure on the local forest (**K**).

A monitoring programme for lake health and a database of information is being developed as part of SDAP to support the "enabling conditions for effective water regulation and governance, sustainable land and natural resource use and sustainable development in the Lake Naivasha Basin".
Imarisha has been awarded 400,000 Euro by GIZ (German International Cooperation Fund) to assist with schemes such as the promotion of alternative renewable energy sources and the development of riparian evaluation techniques for community monitoring to provide future evidence of successful restoration and to organise knowledge transfer from the scientific community to the Naivasha stakeholders (**H**).

In 2013, Imarisha, in partnership with WWF, received 900,000 Euros Dutch Government funding launched the Integrated Water Resource Action Plan (IWRAP), which will underpin the rising sales of Fair Trade flowers to European supermarkets.

The research carried out by Harper and colleagues at Leicester is helping to save and restore both the lake and the thriving businesses around it for future generations.

5. Sources to corroborate the impact

A. WWF Kenya *Shared Risk and Opportunity in Water Resources: Seeking a Sustainable Future for Lake Naivasha*, September 2012. http://awsassets.panda.org/downloads/navaisha_final_08_12_lr.pdf

B. Letter from Hon Secretary, Lake Naivasha Riparian Association.

C. Burton, A. (2012) Floating islands to restore Rift Valley lake. *Dispatches; Frontiers in Ecology*, Ecological Society of America, **10**; 9, 459, November 2012

D. **Harper, D.M**., Pacini, N., **Upton, C., Morrison, E.H.J**., Fox, R. and Kiminta, E (2013). Water Cooperation for Sustainable Utilization: Lake Naivasha, Kenya, p 256-259. In *Free Flow – Celebrating 2013 as the Year of Water Cooperation, ed* UNESCO. Tudor Rose (Leicester) for UNESCO, Paris.

E. http://www.wwf.org.uk/what_we_do/safeguarding_the_natural_world/rivers_and_lakes/where_we_work/east_africa/kenya___lake_naivasha.cfm

F. Visit by Price of Wales ISU http://www.environment.go.ke/image-gallery/april-2011/pm-launches-imarisha-naivasha-program

G. http://www.imarishanaivasha.or.ke/

H. Imarisha Naivasha *Sustainable Development Action Plan*, September 2012. Imarisha Naivasha Board, P.O. Box 2122-20117, Naivasha, Kenya. http://www.water-energy-food.org/

I. Lake Naivasha Integrated Management Plan 2012-22 ftp://ftp.itc.nl/pub/naivasha/imarisha/LNB_Mgt_Plan_28March2012.pdf

J. Floating islands http://www.finlays.net/environment/floating-islands

K. *'Papyrus charcoal offers Kenyans new fuel source'* http://planetearth.nerc.ac.uk/news/story.aspx?id=1522