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ENVIRONMENTAL SYSTEMS AND SOCIETIES
STANDARD LEVEL
PAPER 2

Thursday 7 November 2013 (afternoon)

2 hours

RESOURCE BOOKLET

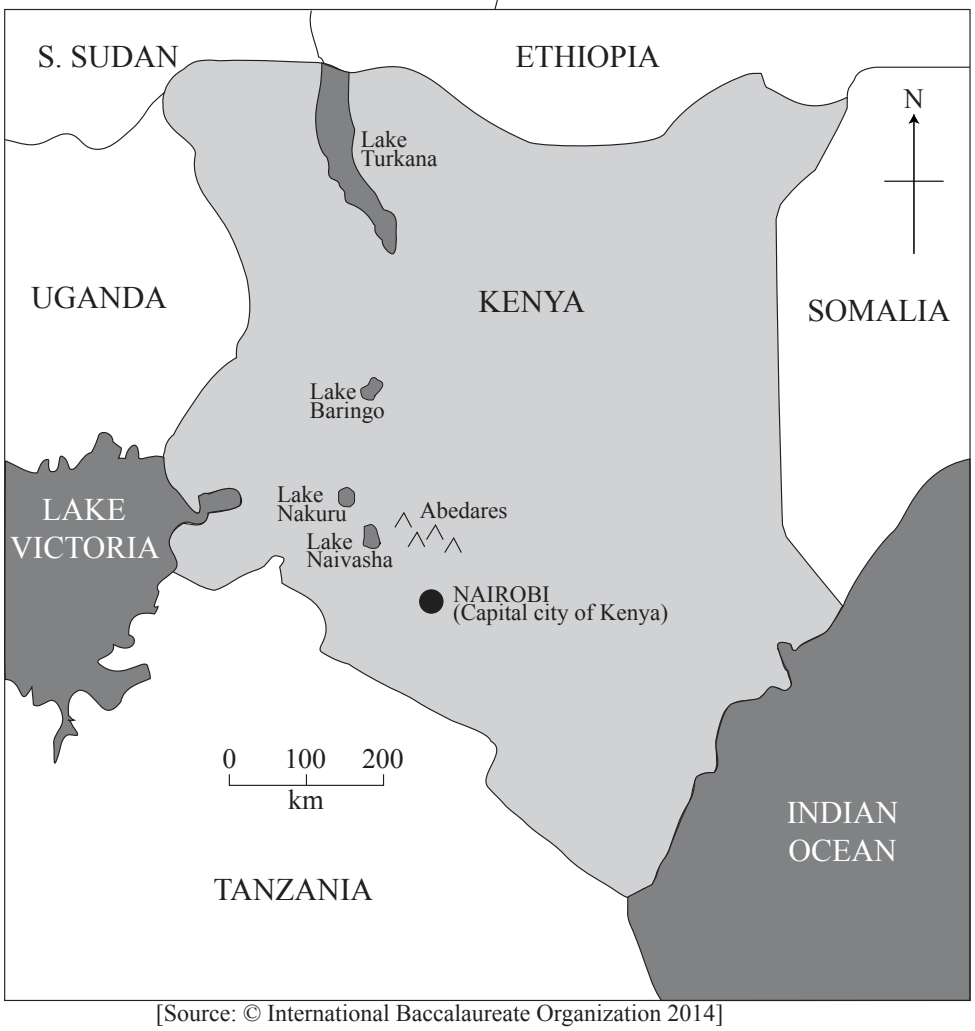
INSTRUCTIONS TO CANDIDATES

- Do not open this booklet until instructed to do so.
- This booklet contains **all** of the resources required to answer question 1.

Figure 1: Maps showing the area covered by this study.

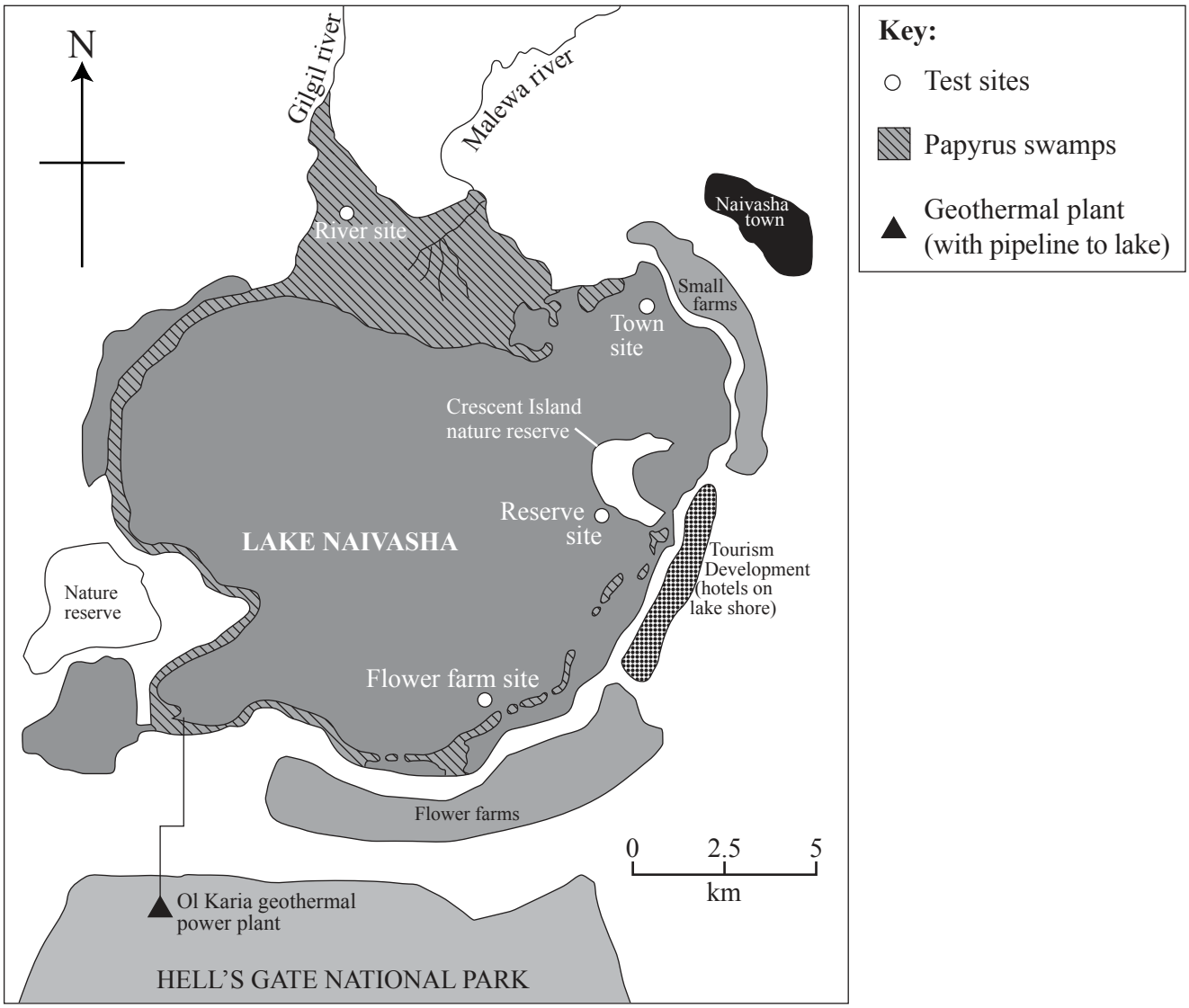
(a) Maps showing the location of Kenya and neighbouring countries

[Source: © International Baccalaureate Organization 2014]



[Source: © International Baccalaureate Organization 2014]

(b) Detailed map of Lake Naivasha, Kenya



[Source: © International Baccalaureate Organization 2014]

Figure 2 Fact file on Kenya

Population (2010)	40 million
Population growth rate (%/year)	2.6%
Literacy	85.0%
Population below poverty line (living on less than $2 a day)	50.0%
Percentage of people connected to the grid (electricity)	9.0%
Traditional fuel consumption for example wood, charcoal (as a % of total energy used)	70.6%
Electricity production from oil	23.0%
Electricity production from hydro-electricity	68.0%
Electricity production from geothermal sources	9.0%

[Source: adapted from Recipes country info Kenya.pdf and CIA world factbook]

Figure 3 Fact File on Lake Naivasha and its ecology

- Situated within the tropical grassland biome.
- Naivasha is the only freshwater lake in the Rift Valley in Kenya. The others are alkaline or saline.
- Naivasha is a relatively small and shallow lake (average 6m deep).
- The surface area of the lake varies from 102 km^2 to 150 km^2 due to irregular rainfall.
- The main water sources are the Malewa and Gilgil rivers, rain from storms over the nearby Abedare mountain range, and groundwater flow.
- Water leaves the lake by evaporation, transpiration from aquatic vegetation and as underground flow.
- The lake and its shoreline provide diverse habitats for mammals, including hippo and colobus monkeys, birds (for example: African fish eagle) and fish (for example: tilapia, black bass).
- The lake supports a high but uneven biodiversity – rich in birds and plants but no native fish.
- Papyrus is found at the edges of the lake. Papyrus swamps have the potential to sequester large amounts of the carbon (1.6 kg cm^{-2} y^{-1}) provided water levels remain high.

[Source: © International Baccalaureate Organization 2014]

Hippo
(Hippopotamus amphibius)

Colobus monkey
(Colobus guereza)

Papyrus
(Cyperus papyrus)

Water hyacinth
(Eichornia crassipes)

Malachite king fisher
(Alcedo cristata)

African fish eagle
(Haliaeetus vocifer)

Tilapia
(Oreochromis leucostictus)

Crayfish
(Proambarus clarkii)

[Source: adapted from http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=5938560]
[Source: **Hippo:** http://en.wikipedia.org/wiki/File:Hippopotamus_-_04.jpg
Colobus monkey: http://upload.wikimedia.org/wikipedia/commons/thumb/6/6b/Colubusmonkey.JPG/200px-Colubusmonkey.JPG
Papyrus: http://commons.wikimedia.org/wiki/File:Cyperus_papyrus_hannes.JPG by Hannes Karnoeffel.
Water hyacinth: http://commons.wikimedia.org/wiki/File:Eichhornia_crassipes-infl.jpg
Malachite king fisher: http://en.wikipedia.org/wiki/File:Malachite_Kingfisher_-_Portrait.jpg
African fish eagle: http://en.wikipedia.org/wiki/File:African_fish_eagle_just_caught_fish.jpg
Tilapia: http://en.wikipedia.org/wiki/File:Oreochromis-niloticus-Nairobi.JPG
Crayfish: http://en.wikipedia.org/wiki/File:Procambarus_clarkii.jpg]

Figure 4 Features of water hyacinth

- a surface-floating plant
- native to South America
- can double in biomass every 15 days
- can reduce oxygen and sunlight levels and reduce diversity
- abundant in nutrient rich environments

[Source: www.tropical-biology.org]

Figure 5 Economic Activity supported by Lake Naivasha

- The lake supports flower growing, geothermal power generation, tourism, fishing and dairy farming.
- The flower industry is dependent on irrigation from the lake. Flowers represent 75 % of Kenya's horticultural exports and their production employs over 250 000 people. Flower farms are typically very large (over 60 hectares) and involve inputs of fertilisers and pesticides.
- Much of the remaining land is farmed on a subsistence basis as shambas (smallholdings).
- Approximately 9 % of Kenya's electricity is supplied by the Ol Karia geothermal plant. There is scope to expand the production of geothermal power considerably.

[Source: http://www.squidoo.com/walking-safari]

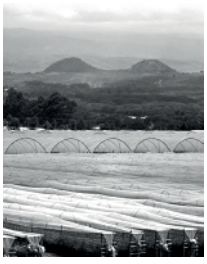
Image removed for copyright reasons

Tourism on Crescent Island Nature Reserve

Ol Karia geothermal plant

Image removed for copyright reasons

Naivasha town



Geothermally heated greenhouses for the flower farms

[Source:
Ol Karia Geothermal: www.businessdailyafrica.com/Corporate-News/Kengen-embarks-on-expansion-with-two-steam-plants-/-/539550/1321618/-/on11q9/-/index.html.
From the *Business Daily*, 6 February 2012, published by the Nation Media Group, used with permission.
Flower farm: http://libertykenya.files.wordpress.com/2011/06/flower.jpg]

Figure 6 Population growth in the Naivasha area

Year	Approximate number of people
1969	45 000
1979	95 000
1989	105 000
1999	160 000
2005	250 000
2009	300 000

[Source: Jimoh, Vogler & Waters_2007.pdf www.tropical-biology.org]

Figure 7 Threats to Lake Naivasha

The rising population has led to an increasing demand for land, firewood, charcoal, and timber, leading to deforestation and increased soil erosion. Lake Naivasha's biodiversity is critically threatened by habitat destruction, pollution (from pesticides, herbicides, fertilizers and sewage), nutrient enrichment, introduction of alien species (for example: exotic crayfish), invasion of the water hyacinth, siltation due to over grazing, shore line vegetation destruction (for example: harvesting of papyrus) and excessive water abstraction (removal). Most of the water abstractions are not measured. Only a small section of Naivasha town is covered by sewerage systems. The sewage treatment works broke down ten years ago.

[Source: adapted from http://whc.unesco.org/en/tentativelists/1345/]

Figure 8 The Ramsar Convention and Lake Naivasha Riparian Association

The Ramsar Convention is an intergovernmental treaty that provides the framework for the conservation of wetlands and their resources. At the centre of Ramsar is the "wise use" concept. The wise use of wetlands is defined as "the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development".

The Lake Naivasha Riparian Association (LNRA) was founded in 1929 by the landowners surrounding the lake. Today the LNRA is actively involved in coordinating a plan to control the forces that threaten the lake's quality and beauty and to promote the sustainable development of the lake. There are nearly 140 members including: tour operators, the Kenya Power Company, flower growers, local farmers and the local council.

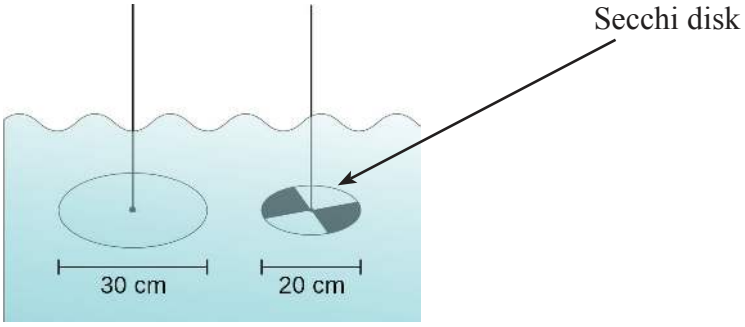
Recent measures taken by LNRA
- Putting in drip irrigation technology
- Installing some water meters
- Controlling pesticide use
- Introduction of codes of conduct for the flower farms, geothermal plant and tourism industries
- Restoration of sewage treatment plant.

[Source: adapted from http://web.ncf.ca/es202/naivasha/who_are_we.html]
[Source: http://www.ramsar.org/cda/en/ramsar-augusthomepage/main/ramsar/1%5E25263_4000_0__]

Figure 9 (a) Pollution study method used to test water quality at Naivasha

At each sample site, water pH, temperature, and transparency were measured from the side of the boat two metres from the edge of any water hyacinths.

Transparency was measured by lowering a Secchi disk into the water and measuring the depth in cm at which the white part is no longer visible. This gives a measure of turbidity.



500 cm^3 water samples were also taken for laboratory analysis to test for algae concentration.

Relative abundance of floating water hyacinths was measured at each site using 1 × 1 m quadrat frames placed on the vegetation surface from the side of the boat.

[Source: Text: http://goodjesuitbadjesuit.blogspot.com
Jimoh, Vogler & Waters_2007.pdf www.tropical-biology.org
Image: http://en.wikipedia.org/wiki/File:Secchi_disks.svg by Mysid]

Figure 9 (b) Results of water pollution study

Sample site	Temperature / °C	pH	Transparency / cm	Water hyacinth % cover	Algae $mg \times m^{-3}$
River	16.1	7.28	16.9	47.8	18
Town	21.6	7.93	31.3	45.0	201
Flower farm	22.0	8.80	39.5	63.7	361
Pristine	22.9	8.70	68.3	30.7	166

[Source: Reproduced with permission from Jimoh, Vogler and Walters, 2007, a student project published by the Tropical Biology Association, www.tropical-biology.org]