Diploma Programme
Programme du diplôme
Programa del Diploma

Environmental systems and societies
Standard level
Paper 2

Tuesday 22 November 2016 (afternoon)

2 hours

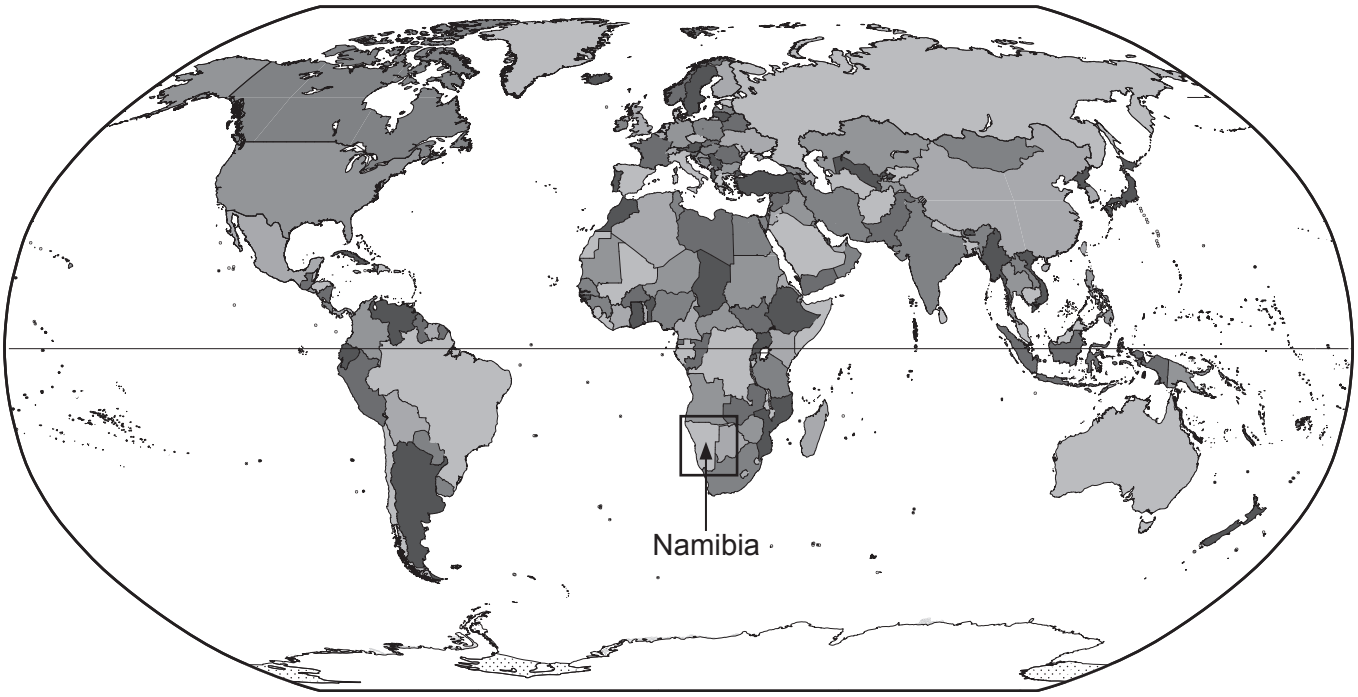
Resource booklet

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.

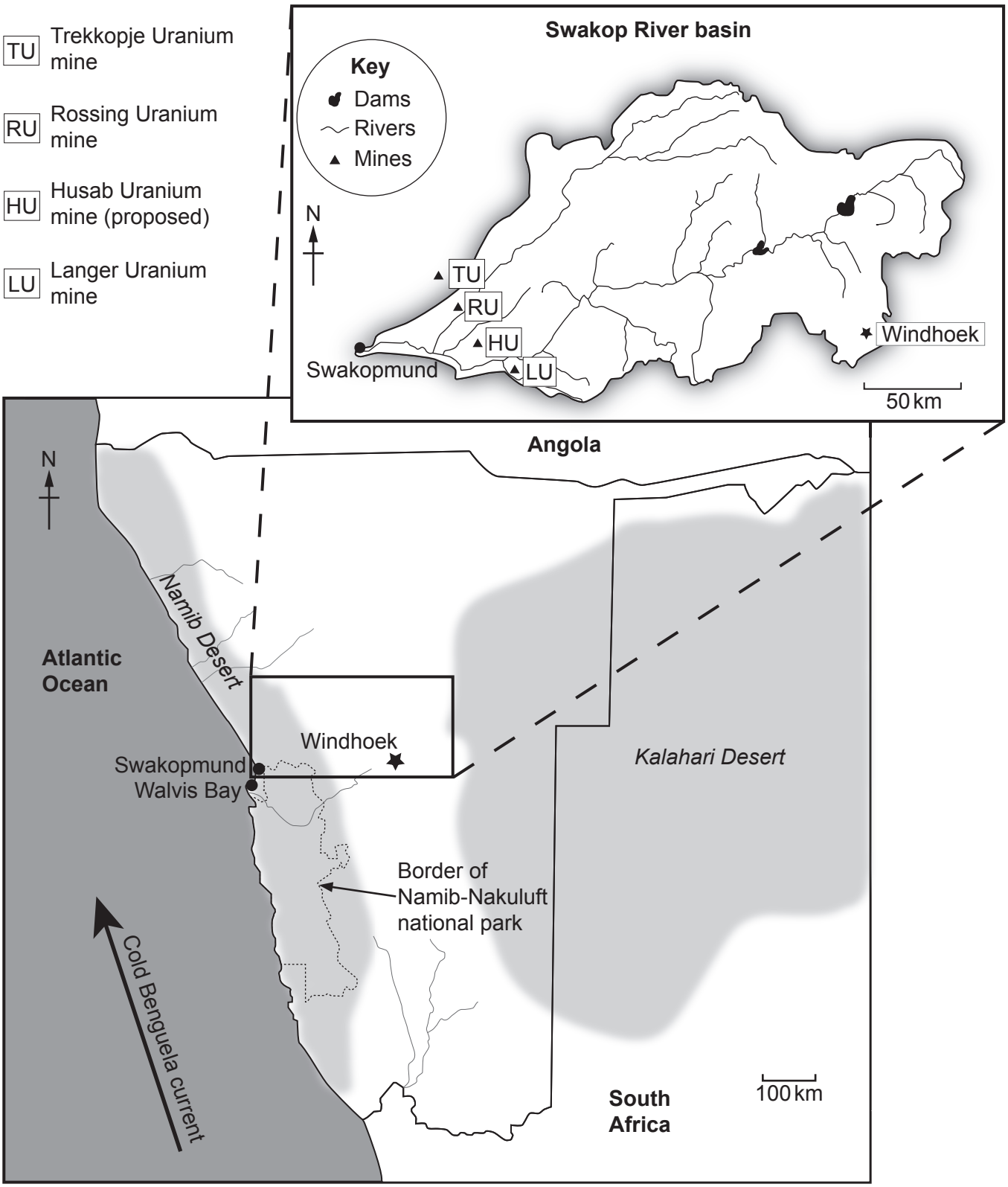
8816 – 6303

Figure 1(a): World map showing the location of Namibia



[Source: adapted from CIA World Factbook]

Figure 1(b): Map showing Swakop River in Namibia



[Source: © International Baccalaureate Organization 2016]

Figure 2: Fact file on Namibia

- 92 % of Namibia is defined as arid or semi-arid.
- Population of 2.2 million (2014).
- GDP per capita US$5461 (2013).
- 28.7 % of the population is living on less than US$2 a day.
- 4th largest producer of Uranium (fuel for nuclear energy) providing 10 % of the world's Uranium.
- Mining sector employs only 1.8 % of the population.
- Tourism contributes 14.2 % to Namibia's GDP, second only to mining.
- Namib-Naukluft Park is a popular tourism destination in Namibia.
- Commercial farmers in the Swakop River basin mostly farm cattle and goats, but also ostriches and kudu.

Figure 3(a): Ecological features of Swakop River Valley

- The river passes through diverse ecosystems:
  - 29 % of the area is in highveld savanna
  - 28 % in thorn forest
  - 34 % in semidesert
  - 9 % in Namib Desert.
- The river mouth is rich in bird life such as the Lesser Flamingo (*Phoenicopterus minor*).
- Unusual plant species occur, adapted to dry conditions such as Welwitschia (*Welwitschia mirabilis*), which is endemic (only found here).
- Coastal fogs (condensed water) sustain many animals and plants, for example the Namib desert beetle (*Stenocara gracilipes*).
- Flora include Ana trees (*Faidherbia albida*) and Tamarisk (*Tamarix usneoides*).
- Mesquite (*Prosopis glandulosa*) is a non-native and invasive species (spreads rapidly).
- Fauna are limited to antelope such as Oryx and Springbok, smaller predators and birds.
- Big game such as elephants, rhinos and lions were present as recently as 1934 but are no longer there as the groundwater levels have dropped.

[Source: Adapted from https://en.wikipedia.org/wiki/Swakop_River]

Figure 3(b): Species found in the Swakop River Valley

Welwitschia (*Welwitschia mirabilis*)

[Source: http://en.wikipedia.org/wiki/Namib_Desert#mediaviewer/File:Welwitschia_mirabilis(1).jpg, by Thomas Schoch – own work at http://www.retas.de/thomas/travel/namibia2003]

Tamarisk (*Tamarixus usneoides*)

[Source: www.plantzafrica.com]

Ana tree (*Faidherbia albida*)

[Source: https://en.wikipedia.org/wiki/Faidherbia#/media/File:Faidherbia_albida.JPG, by Marco Schmidt]

Mesquite (*Prosopis glandulosa*)

[Source: https://en.wikipedia.org/wiki/Prosopis_glandulosa#/media/File:Prosopis-glandulosa-foliage.JPG, by Don A.W. Carlson]

Springbok (*Antidorcas marsupialis*)

[Source: https://en.wikipedia.org/wiki/Springbok#/media/File:Antidorcas_marsupialis,_male_(Etosha,_2012).jpg, by Yathin S Krishnappa]

Namib desert beetle (*Stenocara gracilipes*)

[Source: https://en.wikipedia.org/wiki/Stenocara_gracilipes#/media/File:Stenocara_gracilipes.jpg, © Hans Hillewaert]

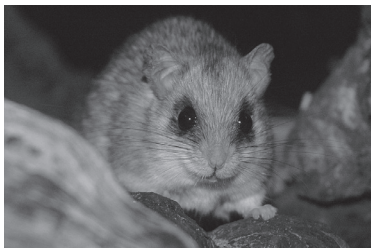
Lesser Flamingo (*Phoenicopterus minor*)

[Source: https://en.wikipedia.org/wiki/Lesser_flamingo#/media/File:Lesser-flamingos.jpg by Charles J. Sharp]

Oryx (*Oryx gazella*)

[Source: https://commons.wikimedia.org/wiki/File:Oryx_gazella_male_8054.jpg, by Alchemist-hp (talk) (www.pse-mendelejew.de)]

Acacia rat (*Thallomys paedulcus*)



[Source: https://en.wikipedia.org/wiki/File:Akazienrattecele4.jpg, photographed by Marcel Burkhard alias cele4]

Common Duiker (*Sylvicapra grimmia*)

[Source: https://en.wikipedia.org/wiki/Common_duiker#/media/File:Common_Duiker1.jpg, by Masteraah]

Turn over

Figure 3(c): Fact file on the Swakop water resources

- The river flows 460 km from near Windhoek, through the Namib Desert, to the Atlantic.
- Of total precipitation:
  - 83 % evaporates
  - 14 % is used up by vegetation
  - 1 % recharges groundwater
  - 2 % becomes runoff.
- The river is an ephemeral river (not there all the time), that floods once in every 10 years carrying lots of debris to the sea.
- Animals use the river as a corridor (linear oasis) to get through arid environments.
- Water from the Swakop River is stored in two major dams.
- Groundwater provides a buffer against drought and water supply for human populations but it is vulnerable to over-abstraction and contamination from Uranium mines.
- Climate scientists predict that global warming could lead to more severe and frequent droughts, but also to a higher likelihood of flash floods in Namibia.

Figure 3(d): Vegetation along the Swakop River corridor (river is dry).

[Source: http://www.hydrology.uni-freiburg.de/abschluss/Marx_V_2009_DA.pdf on p. 31, Fig. 6]

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Figure 4(a): Mesquite as a non-native invasive species

- Mesquite is a non-native species, brought in accidentally to Namibia from Mexico in 1912.
- It spreads rapidly (invasive species) and takes up lots of water.
- Seeds are spread downstream by flash floodwaters.
- Studies have shown Mesquite has negative effects on native vegetation, birds and insects.

Figure 4(b): Investigation into the impact of Mesquite on mammals in the Swakop River Valley

- Scientists wanted to investigate how Mesquite might affect native wild mammals.
- Camera traps were placed in two woodlands, one with lots of Mesquite, the other with low amounts.
- Camera traps were fitted to stakes, at a height of 45 cm.
- The number of photos of each species was recorded.
- Photos were taken over a period of 100 days.

The data in the table show the number species captured by camera shots, in two areas of different mesquite densities, over 100 days.

Species		**Photo capture rate (number of photos in 100 days) in high mesquite area**	**Photo capture rate (number of photos in 100 days) in low mesquite area**
Common name	**Scientific name**		
Steenbok	*Raphicerus campestris*	101	92
Baboon	*Papio ursinus*	109	32
Oryx	*Oryx gazella*	7	61
Kudu	*Tragelaphus strepsiceros*	31	7
Jackal	*Canis mesomelas*	19	13
Duiker	*Sylvicapra grimmia*	1	26
Wildcat	*Felis silvestris lybica*	14	7
Klipspringer	*Oreotragus oreotragus*	11	5
Springbok	*Antidorcus marsupialis*	4	6
Rodent	—	1	9
Porcupine	*Hystrix africaeaustralis*	9	0
Mountain zebra	*Equus zebra*	2	4
Badger	*Mellivora capensis*	0	5

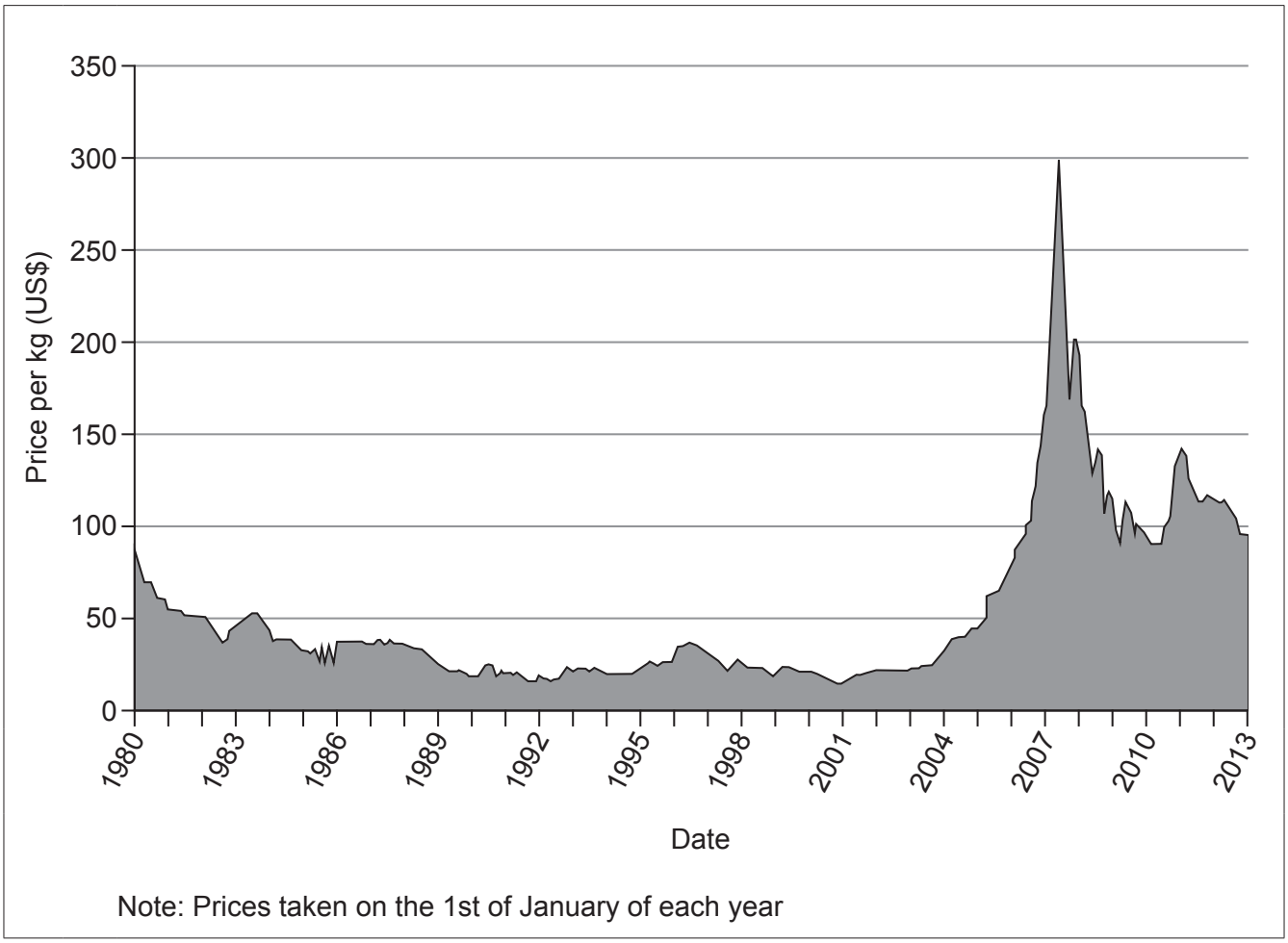
[Source: Williams, D., Pettorelli, N., Henschel, J., Cowlishaw, G. and Douglas, C. M. S. (2014), Impact of alien trees on mammal distributions along an ephemeral river in the Namib Desert. Afr. J. Ecol., 52: 404–413. doi:10.1111/aje.12134]

Figure 4(c): Economic costs and benefits of Mesquite

- Most Namibian farmers see the Mesquite as an alien invasive plant species.
- But Mesquite has many features that make it useful. It grows extremely rapidly, has very dense shade, produces a seed pod in great abundance that is eaten by animals and humans, and is readily available as firewood.
- According to a recent study, harvesting 5 % of Mesquite pods would bring in N$8 million (approximately US$1 million) per year.
- But less than 1 % of the potential income from Mesquite pods is currently being generated.
- Commercial farmers prefer that Mesquite be removed, because it has a negative effect on their farms, but poorer communities benefit by collecting and selling Mesquite pods, or using them to feed their animals.

[Source: http://allafrica.com]

Figure 5(a): Graph to show Uranium prices from 1980 to 2013



[Source: Mongabay.com]

Figure 5(b): Husab Uranium project

- Husab is a new Uranium mine proposed by a local company using Chinese investment.
- The reserves of the mine contain the highest grade (quality) Uranium deposit in Namibia.
- Once in production Husab will be the second-largest Uranium mine in the world.
- The Husab mine is estimated to contain approximately 280 million tonnes of Uranium ore that would take 20 years to mine.

Figure 6(a): Strategic Environmental Management Plan (SEMP) for the Swakop Valley

- The three mines in the Swakop Valley require 10 million cubic metres of water a year. Groundwater aquifers now have very low volumes of water as demand from the mines and surrounding towns rises.
- The SEMP is based on studies that examine the effects of Uranium mining on the environment and communities of the Swakop Valley.
- The two tables below show the findings for two environmental indicators related to the effect of mining on water resources.

	Water for communities is of acceptable quality
Target 4.1	Uranium mining does not compromise community access to water
Indicator	Water quality conforms to minimum Namibian standards for levels of inorganic pollutants, radio-nuclides and bacteria
Status	Not met

	The natural environment and communities have access to adequate water
Target 4.2	Uranium mining does not compromise surface and ground water availability
Indicator	Ground water removal does not exceed the aquifers sustainable yield
Status	Not met

[Source: adapted from www.mme.gov.na]

Figure 6(b): Impact of Uranium mining on Welwitschia

- Welwitschia is an endemic species which does not conserve water like many other desert species. It depends on a stable source of groundwater for its long-term survival, growth and reproduction.
- The Husab Mine would be developed next to a population of the plants. Although the mine will not directly affect more than a few individual plants, its waste rock dumps may affect water supply to a large proportion of the population.

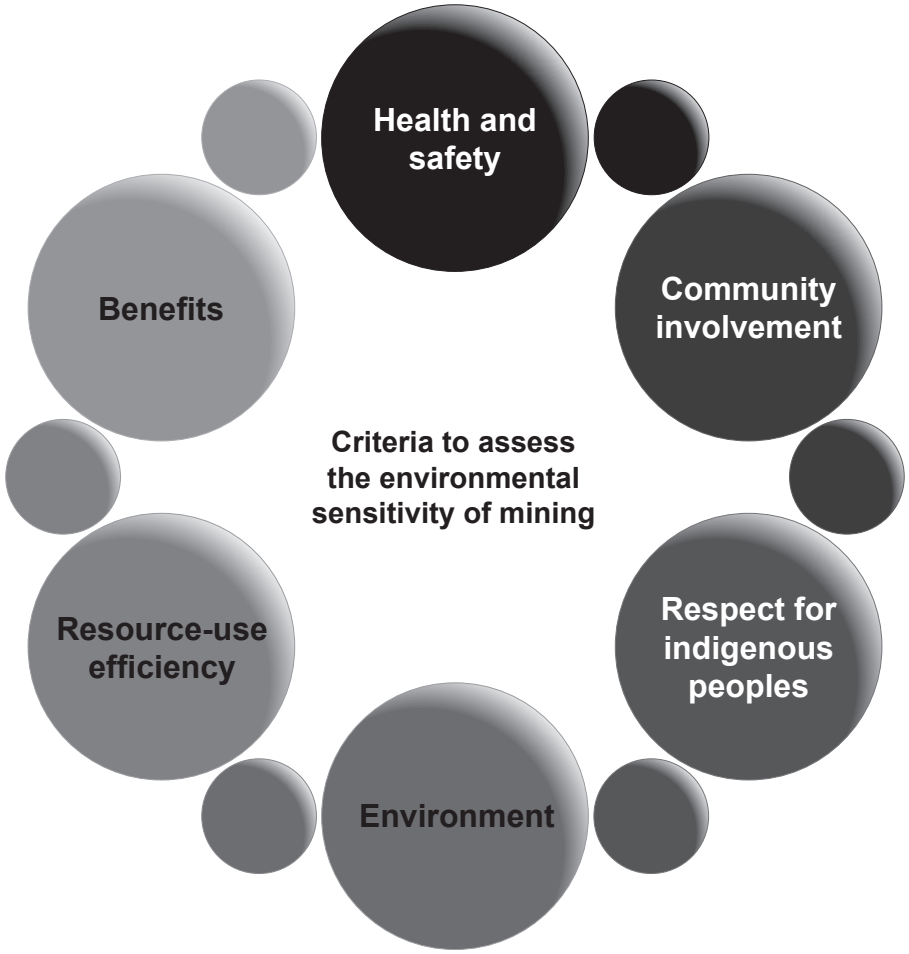
[Source: adapted from www.gobabebtrc.org]

Figure 7: Erongo water desalination plant

- The Erongo desalination plant was built to convert saltwater from the Atlantic Ocean into freshwater for a new mine called Trekkopje. The total production of freshwater from salt water is 20 million cubic metres a year.
- However after the Fukushima nuclear accident the demand for Uranium dropped and the Trekkopje mine did not open.
- The desalination plant now supplies water to the existing Uranium mines in the area, and has spare capacity that could be used to provide water to the communities in the Swakop Valley and to the proposed Husab mine.

[Source: Adapted from http://www.world-nuclear-news.org/C-Areva_water_plant_to_supply_Namibian_mines-1908134.html]

Figure 8: Criteria for assessing the environmental sensitivity of mining



[Source: adapted from https://miningandblasting.files.wordpress.com]