For the celebration of International Environmental Day 2007, focused on the issue of “climate change”, the Ministry of Environmental Affairs has the honor to introduce this simple study to clarify the effects of climate change together with some other threats such as overgrazing and harvesting plants for medicinal uses. To what extent will this affect the desert habitats of Egypt such as Saint Katherine Protected Area? And how do they threaten the existence of one of the most endangered butterflies in the world, the Sinai Baton Blue, the world’s smallest butterfly which only lives in Saint Catherine Protected Area?

The Ministry aims to release more such scientific products for children, young people, scientists and decision makers in suitable format. This story is also in the form of children stories for two different age levels, and a claymation movie, besides the present booklet in your hands.

Eng/ Maged George
Minister of State For Environmental Affairs
The world is getting warmer very rapidly

Over the last 10,000 years, the climate in Egypt has changed many times. The overall trend has been a change from wet to increasingly dry conditions, resulting in the very arid climate of modern Egypt. You can see this in the water levels in Lake Qarun, which declined until the Pharaonic period. Then the lake was artificially refilled by canals until the collapse of Rome, when the lake began drying up again. Now we must add in human-induced climate change. What will happen as the world gets rapidly warmer?

The graph shows how the world is warming up. This warming started about 1900, and is almost certainly caused by the scale of human industrial activity throughout the world. The climate models of the world's top climate scientists, reporting to the Intergovernmental Panel on Climate Change, show that across Africa the climate will change considerably. Africa is the continent that has contributed least to human-induced climate change, but will suffer more than other continents.
What will happen in Egypt?

The climate models for Africa show that some parts (tropics and Ethiopia) will get more rainfall. Egypt and Sudan are predicted to get hotter. The net result on the flow of the Nile will be no change, since there will be more rain, but more evaporation.

However, the melting of the icecaps will raise the sea level of the Mediterranean by between 10 and 80 cm, but most likely by almost 50 cm. This will have a dramatic impact on Egypt's coastline, causing great losses of agricultural land, and affecting major cities (Alexandria, Port Said, etc) and millions of people.
Mountain-top islands in the sky

The impact of global warming on wildlife is relatively simple. As the earth warms, species tend to move to cooler climates either towards the Poles or up mountains. However, the appropriate habitat is not necessarily available and this can cause extinction and big problems for conservation. Basically, in terms of the climate, moving a few metres higher in altitude is the equivalent of moving latitudinally very large distances towards the Poles. Thus where there are mountains, wildlife is expected to move up the mountains. This causes isolated leading to islands of particular communities.
The great Ring Dyke of South Sinai

Exactly this process has happened to the highest mountains in Egypt, contained within the huge volcanically-formed Ring Dyke around St Katherine - a structure easily visible from space. This area is very special geologically, biologically and culturally. It is a sacred place for three of the great religions of the world. It contains the world’s oldest monastery that has continuously functioned since its inception in 590 AD - the Monastery of St Katherine. Its importance has been recognised nationally by the Ministry of Environmental Affairs declaring it a Protected Area in 1996, and internationally by UNESCO declaring the entire Ring Dyke area as a World Heritage Site in 2002.

Many species of animals and plants have been marooned on these mountain-tops by increasingly arid conditions over the last 10,000 years. As the world continues to warm with human-induced climate change, there is a risk that these habitats will disappear for ever.
The Sinai Baton Blue: the world's smallest butterfly

We would like to introduce one of these beautiful creatures to you, the Sinai Baton Blue butterfly, with a good claim to be the world’s smallest butterfly. It is absolutely tiny!

Males are quite a bit smaller than females: the smallest of the males has wings only just over 6 mm long.

Eggs are laid and the caterpillars feed only on the flowers and buds of one plant, the Sinai Thyme (Thymus decussatus). This is another species that only occurs on the tops of the highest mountains in the Ring Dyke of South Sinai.

Sinai Thyme grows in patches of various sizes only on mountains near the town of St Katherine, and one other place in the world - the neighbouring mountains of the Hejaz in Saudi Arabia.
The role of ants

In 2004, Mike James found that Sinai Baton Blue butterflies could breed successfully on some, but not all of the thyme plants. On other plants, the caterpillars do not survive to become adults. Why?

He found that the success of breeding depended on the distribution of two species of ant that also live on the thyme. Successful emergence of adult butterflies is associated with one ant species, whilst failure is associated with a different ant species.

In fact, one ant (Lepisiota) protects the larvae because they give it some kind of sugary substance which it likes. In contrast, the other ant (Crematogaster) eats larvae as food.
The butterfly needs ants

Some kind of interaction between the ants makes it impossible for them to live together under a single plant, and therefore one ant (Lepisiota) protects the caterpillars from the other ant (Crematogaster). The food web containing the butterfly is therefore extremely important to its survival.
The butterfly is a weak flier

Adult butterflies are extremely poor fliers, rarely moving more than 100 m from where they emerged. Thus most individuals never leave their natal patch of thyme, and rarely move between patches of thyme. The butterfly population on each patch can die out for all sorts of reasons, but the larger the population, the less likely this is to happen. If extinction of a population happens, it can only be re-established by colonisation from another patch. Because of their poor flight, the further away the patch is, the harder and therefore less likely the recolonisation will be. Thus two main factors affect the likelihood of long-term survival: patch areas (affecting population size; larger populations are less likely to go extinct), and distances between patches (influencing how easy it is to recolonise a patch). This means that there is a real risk that the entire known world population of the Sinai Baton Blue butterfly could become extinct within a very short time.

This map shows the entire world distribution of the butterfly. On the map are all the known patches of Sinai Thyme in Egypt. Notice there are 3 sets of patches:

1. Gebel Safsafa
2. Gebel Ahmar
3. Wadi Gebal

white = without butterflies
black = with butterflies

(1) Gebel Safsafa (2) Gebel Ahmar (3) Wadi Gebal

This map is not to scale and has been simplified for clarity.

The town of St Katherine and St Katherine's monastery are marked on the map.
Extinction risks to the Sinai Baton Blue

- Global warming & normal year-to-year climate variation
- Grazing intensity
- Over-collection of thyme for medicinal purposes

We can use a computer model to explore the probability of different outcomes for the network of butterfly populations.
Global warming & climate variation

A hotter and drier climate leads to suitable habitat patches of Sinai Thyme moving higher up the mountain and their total area getting smaller.

There is year-to-year climate variation as well. A dry year can reduce plant flowering by 40% or more, enhancing the risk of extinction. South Sinai currently suffering from 15 years of ongoing drought.
Grazing pressure

An immediate threat to the butterfly’s habitat is grazing pressure and this depends on altitude and distance from settlements. Grazing reduces the sizes of patches of Sinai Thyme, and therefore reduces the available habitat for the butterfly. The rangers of the St Katherine Protectorate have carried out a wonderful study of the patterns of grazing around the town. They attached GPS loggers to goats, and then allowed them to go with their herds in their normal pattern, providing positions every few minutes.

The results showed that grazing intensity depends on altitude. The higher wadis are grazed less. Each village has its own area of grazing, and each family’s goats graze in a slightly different place. Thus grazing pressure is lower, further away from the villages.

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Over-collection for medicinal purposes

Like many of the plants in Sinai, thyme contains essential oils that are useful in treating diseases. The Bedouin have used these plants for millenia in their traditional medicines. Modern industrial uses require large amounts of material, and therefore collection of herbs is increasing. This kind of collecting can eliminate a whole patch in one go.
Interactions between threats: global warming and grazing

We can use a computer model to explore the relationship between global warming, grazing and over-collection. This graph explores the relationship between global warming and grazing, derived from the computer model.

The zero on the axis indicates the present-day levels, and therefore each axis indicates gradually increasing impact relative to now. The lines give contours of extinction risk, and we have colour-coded it as well to make it clear: the redder the region, the greater the risk of extinction.

From the graph it is clear that at the moment, with just current year-to-year variation in weather, and current levels of grazing, there is essentially no risk of extinction to the butterfly.

But as global warming increases, so the extinction risk increases. At a certain point, the risk increases very rapidly - essentially there is a threshold of global warming above which the butterfly is very likely to become extinct.

Similarly with grazing pressure - if grazing pressure increases, then the extinction risk increases as well. Again, there is a threshold above which the extinction risk increases very quickly. Furthermore, as is indicated by the curving contours, these two processes interact - they affect each other's impact.

Under reasonable predictions of the extent of global warming over the next century, the butterfly is at a considerable risk of extinction.
Climate change, grazing and over-collection

This graph shows the relationship between over-collecting of plants and global warming. Over-collecting is modelled as the complete loss of single, particular patches of thyme during any one time period.

At any set level of global warming, the model shows that no single patch is critical to the survival of the whole metapopulation, so the future loss of any one patch doesn’t matter (with respect to global warming, anyway). There is no interaction (graph not shown).

However, when over-collection is combined with changing grazing pressure, two particular patches (labelled A and B) are much more important to the survival of the metapopulation than the other patches. When either of these is lost, then there is a substantial increase in the extinction risk if grazing increases (i.e. the colours move down in the graph). These two processes (grazing and over-collection) interact - one influences the impact of the other.

Therefore certain patches are crucial to the long-term survival of the butterfly, and must be protected from over-collection for medicine.
What can be done?

Global climate change can only be tackled by Governments acting together, but every individual can make a contribution by using resources in a more sustainable way. We can use our cars and air-conditioning less, for example.

The threat from over-grazing has already been tackled by the Sinai Bedouin. Traditionally they used to declare certain areas as **half** areas where no grazing was allowed, in order that the vegetation could recover. The St Katherine Protectorate and the Gebaliya Bedouin have together agreed to declare the main area on Safasa as a **half** area, and not to graze there. This practice should be encouraged, maintained and extended to other areas.

The problem of over-collection of thyme can be solved by growing Sinai Thyme artificially in order to supply the demand for medicinal uses.

Everyone can help to make sure that we, the public, are aware about the impact of climate change and other threats on Egypt's wildlife.
Summary

The Sinai Baton Blue is a beautiful and unique creature, the smallest butterfly in the World. Egypt has the only populations in the world, living just in a tiny area around Mt Sinai. It feeds only on an endangered plant, the Sinai Thyme. It is vulnerable to three major threats:

- global warming
- over-grazing
- over-collecting of the food-plant

If increases in these impacts are not prevented, this unique butterfly could be extinct within a few decades.

References

Egypt’s wildlife is beautiful.

Egypt’s wildlife is under threat, and needs protection. Let’s cooperate to preserve the wildlife of Egypt.
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