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roots

Botanic Gardens Conservation International Education Review

April 2008

Climate change
Can we handle it?

The evidence is clear – now for the action

Here comes the sun – gardening with the weather

Carbon offsetting through community involvement

Plants that travel the world

BGCI

Plants for the Planet

Bon Voyage!

BGCI was very sorry to say goodbye to Sarah Kneebone who left us at the beginning of 2007 to take up her new post at the Oman Botanic Garden as Education and Interpretation Expert.

Sarah accomplished an enormous amount during her four years as BGCI's Education Officer, from producing Plants for the Planet CDRom and editing Roots through to organising BGCI's 6th International Congress on Education in Botanic Gardens and the fourth International Diploma Course in Botanic Garden Education.

Sarah also trained over one hundred staff working in botanic gardens in environmental education and interpretation. Her enthusiasm and expertise was highly valued and will be missed in BGCI. However Sarah hasn't left the network and we look forward to continuing contact and finding out how she's getting on.

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Si vous ne supportez pas la chaleur - **allez au jardin**

Si el calor le aprieta - **entre en el jardín**

Julia Willison

If you can't stand the heat - get into the garden

Editorial - English

Climate change is real, immediate and its effects are already being felt around the world. Almost every day brings fresh evidence of shrinking polar ice sheets and receding glaciers, of rising sea-levels and increased flooding in low-lying areas. For years we have watched the inexorable rise in temperatures as our planet heats up and now we are starting to see the impact of global warming on biodiversity from species to ecosystem level. Plants are flowering early, mammals are breaking their hibernation, coral reefs are dying and habitats are changing in their composition. To avoid grave and irreversible disruption to the Earth's climate system, scientists argue that we cannot afford to allow average global temperatures to increase by more than two to three degrees Celcius. Yet the harsh reality may be that, even if the rate of greenhouse gas emissions remain at current levels, the world could face an increase in average temperature of between three to 10 degrees Celsius.

In this Climate Change issue of Roots, we examine how botanic gardens are confronting perhaps the greatest challenge that humankind has ever faced. Encouragingly we show that, far from being complacent about climate change, many botanic gardens are taking the lead in their communities to engage the public in debate and empower them to take action. Barrie Pittock, one of the world's leading scientists in atmospheric research, opens our issue. He reviews the evidence that suggests that climate

Editorial - Français

Le changement climatique est réel, imminent et ses effets se font déjà ressentir partout dans le monde. Presque chaque jour nous apporte des faits nouveaux sur la diminution des calottes glaciaires aux pôles et le recul des glaciers, sur la montée des niveaux des mers et l'augmentation des inondations dans les régions basses. Pendant des années nous avons observé la montée inexorable des températures alors que notre planète se réchauffe et nous commençons maintenant à voir l'impact du réchauffement global sur la biodiversité, depuis les niveaux de l'espèce jusqu'aux écosystèmes. Des plantes fleurissent prématurément, des mammifères interrompent leur hibernation, des bancs de corail meurent et des habitats changent dans leur composition. Afin d'éviter des perturbations graves et irréversibles du système climatique de notre Terre, les scientifiques pensent que nous ne pouvons nous permettre de laisser augmenter les températures moyennes globales de plus de deux ou trois degrés Celsius. Or en réalité, même si les taux d'émission des gaz à effet de serre restaient aux niveaux actuels, le monde pourrait se trouver face à une augmentation des températures moyennes d'entre trois à dix degrés Celsius.

Dans ce numéro de Roots intitulé « Changement Climatique », nous examinons comment les jardins botaniques confrontent ce défi, qui est peut-être le plus grand que l'humanité ait jamais relevé. D'une manière encourageante nous pouvons montrer que, loin d'être prétentieux au sujet du

Editorial - Español

El cambio climático se ha hecho realidad, es inmediato y sus consecuencias ya se sienten por todo el mundo. Casi cada día llegan nuevas evidencias de la pérdida de grosor de las capas del hielo polar y el retroceso de los glaciares, del aumento del nivel del mar y de las inundaciones en tierras bajas. Durante años hemos presenciado el inexorable incremento de las temperaturas, y ahora comenzamos a comprobar el impacto del calentamiento global sobre la biodiversidad, desde el nivel de especie hasta el de ecosistema. Las plantas florecen más temprano, los mamíferos rompen su invernación, los arrecifes de coral mueren y los hábitats cambian su composición. Los científicos argumentan que, para evitar una grave e irreversible ruptura del sistema climático de la Tierra, no podemos permitirnos un aumento de dos o tres grados Celsius. La cruda realidad puede ser que, aún manteniéndose los actuales niveles de emisión de gases de efecto invernadero, el mundo se enfrenta a un incremento medio de entre 3 y 10 grados Celsius.

En este nº de Roots dedicado al Cambio Climático, examinamos cómo los jardines botánicos afrontan quizás el mayor desafío de la humanidad. Es alentador mostrar la no complacencia con el cambio climático, ya que los jardines están liderando el debate en el público, y animándole para entrar en acción. Barrie Pittock, uno de los más prominentes científicos de la investigación atmosférica, abre este número. Revisa las evidencias que sugieren que el cambio climático se

change is happening at a faster rate than we previously anticipated and leads us to question how we respond to this. Any sensible response will refer to both mitigation and adaptation. Mitigation involves taking action to reduce the extent of global warming, while adaptation looks at how global climate change effects may be reduced.

Of course the extent to which strategy is pursued may be heavily influenced by our ideological perspectives. Those of us who believe that economic growth remains a key driver are perhaps more likely to favour change and innovation and support the view that new technology will resolve the climate change question. This would incline us more towards adaptation strategies. On the other hand, for those among us who share the view that humanity should co-exist with nature and minimise its impact on the planet, then a strategy of mitigation, looking for stability and using regulatory disciplines, may be preferred. Engaging with such apparently contradictory schools of thought may lead us to an understanding that either, or even both, of these approaches may be the most suitable path to take.

Kenya's Green Belt Movement argues the case for a holistic approach to climate change, in which mitigation and adaptation go hand in hand. Through its programme of planting indigenous trees, not only is the GBM addressing climate change, it is also tackling the underlying causes of poverty and environmental degradation. In fact many botanic gardens combine mitigation and adaptation strategies. Articles in this issue of Roots describe public awareness raising programmes in South Africa and Brazil – two countries rich in biodiversity yet particularly vulnerable to the effects of climate change in terms of food security and livelihoods. Both Nopasika Malta Qwathekana and G. Midgley of South African Biodiversity Institute and José Fernando Vargas, Luiza Chomenko and Elisabete da Silva of Rio Grande do Sul's Zoological and Botanical Foundation, Brazil, underline the urgency of their messages and demonstrate how their programmes

changement climatique, beaucoup de jardins botaniques prennent l'initiative dans leurs communautés pour engager le public dans la discussion et lui permettre ainsi d'agir. Barrie Pittock, un des premiers scientifiques mondiaux en recherche atmosphérique fait le début de ce numéro. Il passe en revue les données qui suggèrent que le changement climatique a lieu à un rythme plus rapide que prévu et nous mène à interroger comment nous réagissons à cela. N'importe quelle réponse sensible se rapportera tant à la modération qu'à l'adaptation. La modération comprend les actions à entreprendre pour diminuer l'amplitude du réchauffement global, alors que l'adaptation cherche comment les effets du changement climatique peuvent être réduits.

Le travail du 'Green Belt Movement' au Kenya défend la cause d'une approche holistique au changement climatique, où la modération et l'adaptation vont main en main. A travers son programme de plantation d'arbres indigènes, le GBM ne s'adresse pas seulement au changement climatique, mais aborde aussi les causes fondamentales de la pauvreté et de la détérioration de l'environnement. En fait de nombreux jardins botaniques combinent des stratégies de modération et d'adaptation. Les articles de ce numéro de Roots décrivent des programmes pour développer la prise de conscience du public en Afrique du Sud et au Brésil - deux pays riches en biodiversité mais aussi particulièrement vulnérables aux effets du changement climatique en termes de sécurité et de ressources alimentaires. Aussi bien Nopasika Malta Qwathekana, Directeur de l'éducation à l'Institut de Biodiversité Sud-africain et José Fernando Vargas, Luiza Chomenko et Elisabete da Silva de la Fondation Zoologique et Botanique de Rio Grande do Sul au Brésil soulignent l'urgence de leurs messages et montrent comment leurs programmes interagissent avec une audience aussi grande que possible. Du Royaume Uni, Alison Derby, Conservatrice du jardin botanique de Winterbourne nous décrit comment leur jardin modèle du changement climatique présente des dispositifs qui pourraient être incorporés dans l'environnement domestique pour parer les effets du changement climatique. Le jardin s'adresse aux plus de 60 ans qui, selon

produce a una velocidad mayor que la anticipada, y nos cuestiona cómo vamos a responder a esto. Toda respuesta sensata tiene dos referentes: la mitigación y la adaptación. La mitigación implica reducir activamente la magnitud del calentamiento global, mientras que la adaptación busca cómo reducir las consecuencias del cambio.

Por supuesto que las orientaciones ideológicas personales pueden influir mucho en la adopción de la estrategia. Quienes piensan que el crecimiento económico sigue siendo lo pioritario, están a favor de la innovación apoyando el punto de vista de que con nueva tecnología se resolverá el problema del cambio climático. En consecuencia se inclinan hacia las estrategias de la adaptación. Por otro lado, para aquellos que piensan que la humanidad debe coexistir con la naturaleza y minimizar su impacto en el planeta, la estrategia de la mitigación, que busca la estabilidad y una autodisciplina reguladora, resulta la preferida. Confrontados con dos escuelas de pensamiento tan aparentemente contradictorias podemos llegar a comprender que ambos enfoques es posible que sean compatibles.

El Green Belt Movement en Kenya razona el enfoque holístico del cambio climático en el que la mitigación y la adaptación van de la mano. A través de este programa de plantación de árboles autóctonos, no sólo abordamos el cambio climático, sino también el GBM resuelve las causas subyacentes de pobreza y degradación medioambiental. Es un hecho que muchos jardines botánicos combinan las dos estrategias. Los artículos en este nº de Roots describen los programas de concienciación pública en Brasil y Sudáfrica, dos países ricos en biodiversidad y, sin embargo, vulnerables a los efectos del cambio en términos de seguridad alimentaria y de medios de vida. Tanto Nopasika Malta Qwathekana y G. Midgley del South African Biodiversity Institute, como José Fernando Vargas, Luiza Chomenko y Elisabete da Silva, de la ciudad de Rio Grande do Sul (Fundación Zoológica y Botánica), Brasil, subrayan la urgencia de los mensajes y demuestran cómo sus

interact with as wide an audience as possible. From the UK, Alison Derby, Curator of Winterbourne Botanic Garden describes how Winterbourne's model climate change garden demonstrates features that could be incorporated in domestic settings to counter climate change effects. The garden is aimed at the over 60's, which according to UK research, represents that part of the population most sceptical about climate change.

Across Europe botanic gardens are effectively getting the climate change message over through the hard-hitting exhibition 'Hard Rain: Our Headlong Collision with Nature'. Sarah Kneebone, former BGCI Education Officer and co-editor of Roots, now Education and Interpretation Expert for Oman Botanic Garden, explains how arresting and often shocking images interpret a classic Bob Dylan song in a way that is intended to engage with people on a more spiritual level. From the reactions and feedback from visitors to the exhibition, this is certainly working.

Long term and sustained engagement with the public on climate change remains a challenge and here the innovative citizen science approach of Chicago Botanic Garden may show a way ahead. Jennifer Schwarz Ballard together with her colleagues Kayri Havens and Pati Vitt describe Project BudBurst (and a second related project still in the planning stage), designed to encourage citizen scientists of all ages to record their phenological observations on the project website. The success of projects such as these surely demonstrate that the public appetite for information about climate change is still keen. They want to become more involved in finding solutions and botanic gardens, with their scientific credentials and resources, are perfect locations for such explorations.

les recherches au Royaume Uni, représentent la partie de la population la plus sceptique à l'encontre du changement climatique.

A travers l'Europe les jardins botaniques font passer de façon très efficace le message du changement climatique à travers l'exposition percutante 'Hard Rain: Notre Collision avec la Nature'. Sarah Kneebone, ancienne responsable de l'éducation à BGCI et coéditrice de Roots, actuellement Directrice de l'éducation au jardin botanique d'Oman, explique comment des images percutantes et souvent choquantes interprètent une chanson classique de Bob Dylan d'une façon qui voudrait atteindre les gens sur un niveau plus spirituel. D'après les réactions et commentaires des visiteurs de l'exposition, cela fonctionne certainement.

Un engagement continu à long terme avec le public sur le sujet du changement climatique reste un défi; c'est ici que l'approche innovatrice du citoyen scientifique du jardin botanique de Chicago peut montrer une voie à suivre. Jennifer Schwarz Ballard, ensemble avec ses collègues Kayri Havens et Pati Vitt, décrivent le projet BudBurst (et un second projet semblable en phase de planification), qui cherche à encourager des citoyens scientifiques de tout âge à enregistrer leurs observations phénologiques sur le site internet du projet. Le succès de ce genre de projets montre certainement que le public est toujours avide d'informations sur le changement climatique. Les gens veulent s'engager plus loin pour trouver des solutions et les jardins botaniques avec leurs qualifications et ressources scientifiques constituent des endroits parfaits pour ces explorations.

programas interactúan con las mayores audiencias posibles. Desde Gran Bretaña, Alison Derby, Curator del Winterbourne Botanic Garden, describe cómo el jardín modelo cambio climático Winterbourne tiene los esquemas e ideas necesarios para que se pueda incorporar en el ámbito doméstico, y así hacer frente a los efectos del cambio. El jardín está diseñado para los de más de 60 años, que según las encuestas de esta nación representa el segmento de población más escéptico con el cambio climático.

Por toda Europa los jardines botánicos consiguen efectivamente expandir el mensaje del cambio climático a través de la impactante exposición 'Hard Rain: Nuestra Temeraria Colisión con la Naturaleza'. Sarah Kneebone, hasta ahora BGCI Education Officer y co-editora de Roots, y actualmente Directora de Educación del Jardín Botánico de Omán, referencia las sorprendentes y a menudo chocantes imágenes que interpretan una clásica canción de Bob Dylan, una forma de empatizar con el público a un nivel más espiritual. Por las reacciones de los visitantes y sus comentarios de la exposición, se ve que está funcionando.

Un desafío pendiente es mantener una relación permanente con el público acerca del cambio climático, y es en este punto donde el enfoque innovador del programa de ciencia y ciudadanía del Chicago Botanic Garden muestra el camino a seguir. Jennifer Schwarz Ballard junto con sus colegas Kayri Havens y Pati Vitt describen el Projecto BudBurst/Floración (y un 2º proyecto relacionado en fase de planificar), diseñado para estimular la observación del ciudadano científico de todas las edades con objeto de registrar la fenología de las plantas a través de la red internet. El éxito de proyectos como éstos demuestran que el apetito del público por información del cambio climático sigue estando vivo. Quieren estar más comprometidos en la búsqueda de soluciones, y los jardines botánicos, con su bagaje científico, credenciales y recursos son el lugar perfecto para tales exploraciones.

Barrie Pittock

Climate change

the evidence is clear – now for the action

Summary The Intergovernmental Panel on Climate Change (IPCC) in 2007 finally acknowledged that humans are at the root cause of climate change. Evidence abounds that the world is heating up, but how quickly and what the impacts will be are open to speculation. The 10 areas of evidence presented here suggest that climate change is happening at a faster rate than anticipated. Considered collectively, the prospect is frightening and it is likely that we will face more serious outcomes than we currently understand. The time for action at all levels is now. Botanic gardens have an acute understanding of the impact of climate change on plant diversity. This needs to be articulated loudly and clearly to the millions of people who visit botanic gardens each year.

Introduction

One of the greatest challenges we face this century is adapting to and mitigating climate change. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report was contributed to by over 2,000 scientists and is a manifestation of our global concern about this issue. It has taken a long time to emerge, but there is now consensus that 'there is little doubt that climate change is happening and the warming of the world…is largely due to human emissions of greenhouse gasses' (IPCC, 2007). The Fourth Assessment Report makes for worrying reading, yet many are concerned that it masks what a growing number of scientists believe are even more serious risks and implications about climate change.

Inevitably there are uncertainties in climate change science. They arise from questions of data quality, inadequate understanding of the climate system and its representation in climate models as well as uncertainties about future emissions of greenhouse gases resulting from socio-economic and technical developments. Policies therefore must be based on risk management. For example, we do not insure our house for the coming year because we are certain it will burn down, but because there is a small chance that it might and this would result in serious consequences for our finances. Better flood protection for New Orleans should have been built before 2005 (Fischetti, 2001), not because it was certain New Orleans *would* be flooded in 2005, but because it *might* have been.

Below, I highlight ten areas of concern based on observations and modelling studies. Looked at collectively, I argue that they suggest we are at greater risk of more serious outcomes than we currently understand – this makes it all the more critical for urgent action at local, regional, national and governmental level. This is something I will mention later in relation to botanic gardens.

Evidence suggesting more rapid climate change

1 The climate sensitivity may be larger than has been traditionally estimated
Recent estimates of climate sensitivity (the global warming after a doubling of the preindustrial carbon dioxide concentration) suggest a range of around 2°C to 6°C (Hegerl *et al*., 2006) and a much higher probability of large global average surface warmings by 2100. Without a policy of drastically reducing greenhouse gas emissions, warming by 2100 would likely exceed 3.0°C above pre-industrial , which is well above what many scientists consider would lead to 'dangerous' climate change impacts (Schellnhuber et al., 2006).

2) Global dimming is large but decreasing
Atmospheric particles (aerosols) reduce the amount of sunlight at the Earth's surface. The resulting 'global dimming' has delayed warming of the oceans (Delworth *et al*., 2005), especially in the Northern Hemisphere. With stricter controls leading to reductions in emissions of particles and precursor compounds (Wild *et al*., 2005), there will be a decrease in the cooling influence these aerosols are having on the climate.

Given that the highest aerosol loading is in the Northern Hemisphere, reductions in global dimming are likely to have asymmetric effects, leading to greater warming in the Northern Hemisphere and to changes in cross-equatorial flows such as the Australian monsoon (Rotstayn *et al*., 2007) and the circulation in the Atlantic Ocean (Cai *et al*., 2006). By contrast, emissions of carbon dioxide (CO_2) and other greenhouse gases exert a long-term warming influence because of their long lifetimes and the resulting cumulative effect on their concentrations. As a result, reductions in global dimming will lead to greater warming in the short term even if the emissions of greenhouse gases are cut back.

3) Permafrost melting and albedo changes
Observations show rapid melting of permafrost, or frozen ground (Arctic Climate Impact Assessment, 2004), which is expected to increase (Lawrence and Slater, 2005). Melting reduces the reflectivity, or albedo, of the surface (Chapin *et al*., 2005), and will likely lead to emissions of CO_2 and methane previously stored in frozen soils. These are positive feedback (or amplifying) effects that may have been underestimated. Where permafrost is replaced by swampland, methane is likely to be emitted, but where it is replaced by dry soil, CO_2 is more likely to be emitted.

4) Biomass feedbacks are kicking in
Saturation of terrestrial carbon sinks, and potential destabilization of large biospheric carbon pools are possible (Canadell *et al*., 2007). Observations of soil and vegetation acting as sources rather than sinks of greenhouse gases (Raupach *et al*., 2006) suggest an earlier-than-expected (Matthews *et al*., 2005) positive feedback in the terrestrial carbon cycle (Scheffer *et al*., 2006). Other factors that may lead to a more rapid global warming include reduced sequestration of root-derived soil carbon (Heath et al., 2005), overestimates of responses to ambient CO_2 increases (Kilronomos *et al*., 2005), and forest and peat fires (Page *et al*., 2002) exacerbated by land clearing and draining of swamps.

Present indications are that emissions, sea level rise and global surface temperatures are all tracking along the highest of the range of estimates from the IPCC's Third Assessment Report (Rahmstorf *et al*., 2007).

5) Arctic sea ice is retreating rapidly
Rapid recession of Arctic sea ice has been observed, leading to an acceleration of global warming as reduced reflection of sunlight increases surface heating (Wang *et al*., 2006). Some scenarios have the summertime Arctic Ocean becoming ice-free by the end of the century. There have also been longer seasonal melt periods, for the sea ice as well as the Greenland Ice Sheet and other land areas, especially since 2002. Serreze and Francis (2006) argue that the Arctic is presently in a state of 'preconditioning', setting the stage for larger changes in coming decades. They state that 'extreme sea ice losses in recent years seem to be sending a message: the ice-albedo feedback is starting'. This has been borne out by record summer ice losses in 2007 (NSIDC, 2007), with some scientists now suggesting that the Arctic could be ice free in summer within a couple of decades.

6) Changes in air and sea circulation in middle and high latitudes
Different rates of warming at low and high latitudes in both hemispheres have led to increasing sea level pressure in the middle latitudes. This partly explains the observed and projected drying trends in winter rainfall regimes in Mediterranean-type climatic zones in both hemispheres (Pittock, 2003). This change has also strengthened the major surface ocean circulations, including the Antarctic Circumpolar Current (Fyfe and Saenko, 2006). These changes will significantly affect surface climate, including sea surface temperatures and storminess (Fyfe, 2003), and may already have accelerated melting in Antarctica (Marshall et al., 2006) and preconditioned the South Atlantic for the formation of tropical cyclones (Pezza and Simmonds, 2005).

7) Rapid changes in Antarctica
Rapid disintegration of ice shelves around the Antarctic Peninsula, and subsequent acceleration of outlet glaciers point to the role of surface meltwater in ice shelf disintegration (Dupont and Alley, 2006) and to the role of ice shelves in retarding glacier outflow. The Larsen B Ice Shelf collapsed spectacularly in 2002, following Larsen A and the Prince Gustav Channel Ice Shelf that both collapsed in 1995. Satellite observations clearly document that the sequence of the Larsen B Ice Shelf collapse involved the sudden disappearance of surface meltwater pools, followed immediately by the opening of crevasses and the break-up of the ice shelf over a period of a few weeks. Strengthening and warming of the Antarctic Circumpolar Current (Fyfe and Saenko, 2006) may accelerate Antarctic ice sheet disintegration by enhancing local warming, preventing sea ice formation, and undercutting ice shelves (Carril *et al*., 2005). Some indirect observations suggest that Antarctic sea ice extent is already in decline (Curran *et al*., 2004), although shorter direct observations are less clear.

8) Rapid melting and faster outlet glaciers in Greenland
The Greenland Ice Sheet is at a generally lower latitude than Antarctica and has widespread marginal surface melting in summer. The area of surface melting has rapidly increased in recent years, notably since 2002 (NASA, 2003, 2006). Penetration of this meltwater through moulins (crevasses and tunnels in the ice) to the lower boundary of the ice is thought to have lubricated the flow of ice over the bedrock and led to accelerated glacier flow rates (Thomas *et al*., 2006). Melting of tidewater glaciers from the bottom, pushing back the grounding line, may also be contributing to acceleration of flow (Bindschadler, 2006).

These observational results indicate mass losses considerably faster than were modelled by glaciologists using models which did not take account of

the recently identified mechanisms of meltwater lubrication and tidewater glacier undercutting (Ridley *et al*., 2005). Simulations and paleo-climatic data indicate that Greenland and Antarctica together contributed several metres to sea level rise at 130,000 to 127,000 years ago, a time when global temperatures were about the same as presently projected for 2100 (Overpeck *et al*., 2006).

9) Tropical cyclones may already be more intense

Some observational analyses point to a rapid intensification of tropical cyclones over recent decades (Hoyos *et al*., 2006). However, modelling of tropical cyclone behavior under enhanced global warming conditions (Walsh *et al*., 2004) suggests only a slow increase in intensity that would not yet be detectable given natural variability. However, according to Pezza and Simmonds (2005), the first recorded South Atlantic hurricane may be linked to global warming.

10) Variations in the North Atlantic Ocean circulation and salinity

The North Atlantic has a complex current system, with the largely wind-driven Gulf Stream splitting into the North Atlantic Current that heads north-east into the Norwegian Sea, and a subtropical recirculating arm, known as the Azores and Canary Currents, which turns south. Relatively warm, but highly saline, surface water in the northern arm tends to sink to a depth of several kilometres in three regions – the Labrador Sea, south of Iceland and between Greenland and Norway. The north-flowing arm transports heat from low latitudes to high latitudes, tending to warm northwestern Europe. Bryden *et al*. (2005) reported a significant slowing of this regional sinking, or 'meridional overturning' circulation, but it may be natural variability (Bindschadler, 2006). Cai *et al*. (2006) and Delworth and Dixon (2006) suggest that without the 'protective' effect of aerosols the slow-down would be 10% greater, indicating further slow-down as aerosols decrease. Any slowdown now or in the future is likely to be related to freshening of surface waters in the Arctic Ocean due to increased precipitation and river inflow and the recent increase in ice-melt from Greenland and other glaciers (Swingedouw, 2006; Pittock, 2008).

We have the evidence, so what's next?

The above lines of evidence (supported by well over 100 recent scientific papers – see Pittock, 2008), while not definitive and in some cases controversial, suggest that the balance of evidence may be swinging toward more extreme global warming and sea-level rise outcomes. While some of the observations may be due merely to natural fluctuations, their conjunction and in some cases positive feedbacks (from permafrost melting, biomass changes, Arctic sea ice retreat, and melting of Greenland) are causes for concern. They highlight the need for us to consider the whole system, not just individual parts in isolation.

The observations and linkages suggest that critical levels of global warming may occur at even lower greenhouse gas concentrations and/or anthropogenic emissions than was considered justified in the IPCC (2007) report. The observed changes in Greenland and Antarctica suggest that a more rapid rise in sea level may be imminent, as has been observed in recent years. Indeed, Rahmstorf *et al*. (2007) find that emissions, global surface temperature and sea level rise are all increasing at rates at the very highest end of the IPCC range. These recent developments increase the urgency of further improving climate models, and of taking action to reduce emissions in order to avoid the risk of unacceptable levels of climate change.

What does this mean for botanic gardens?

As guardians of plant diversity, botanic gardens have an acute understanding of the impact of climate change on plant diversity. According to BGCI's website (BGCI, 2008):

- Plants will be unable to change their distribution fast enough and, those with long life cycles and/or slow dispersal mechanisms, will be particularly vulnerable.
- Isolated plant species such as alpine species and island endemics will also be vulnerable as they will have no where to move to.
- Coastal species will be 'squeezed' between human settlements and rising sea levels
- Plant genetic composition may change in response to the selection pressure of climate change
- Some plant communities or species associations may be lost as species move and adapt at different rates
- Increased invasions by alien species may occur, as conditions become more suitable for exotic species while native species become less well suited to their environment.
- Many plant communities act as 'sinks' which helps to offset carbon emissions. However over the next 70 years, the effects of climate change on plants mean many terrestrial sinks may become sources.

With knowledge comes responsibility. Botanic gardens have a responsibility to provide evidence and to explain to the public about the possible dangerous or unacceptable outcomes of climate change in relation to plant diversity, no matter how alarming or extreme these outcomes may be, and even if the probability of any of them occurring is small. Botanic gardens exist in most countries of the world and through their education and public awareness programmes collectively reach millions of people. They clearly have a significant contribution to make in combating and mitigating climate change.

References

- Arctic Climate Impact Assessment, 2004: *Impacts of a Warming Arctic*, Cambridge Univ. Press, New York. (Available at http://www.acia.uaf.edu)
- (Bindschadler, R., 2006: Hitting the ice where it hurts, *Science*, **311**, 1720-1721
- Botanic Gardens Conservation International, 2008, The Effects of Climate Change on Plants. See www.bgci.org/conservation/climate_change_effects
- Bryden, H. L., Longworth, H. R. and Cunningham, S. A., 2005: Slowing of the Atlantic meridional overturning circulation at 25°N, *Nature*, **438**, 655–657, doi:10.1038/nature04385
- Cai, W., Bi, D., Church, J., Cowan, T., Dix, M. and Rotstayn, L. D., 2006: Pan-oceanic response to increasing anthropogenic aerosols: Impacts on the Southern Hemisphere oceanic circulation, *Geophys. Res. Lett*.,33, L21707, doi:10.1029/2006GL027513

- Canadell, J.G., Pataki, D.E., Gifford, R., Houghton, R.A., Luo, Y., Raupach, M.R., Smith, P. and Steffen, W., 2007), Saturation of the terrestrial carbon sink, Chapter 6 in: *Terrestrial Ecosystems in a Changing World* (ed., Canadell, J.G., Pataki, D. and Pitelka, L., (ed.), Springer-Verlag, Berlin Heidelberg
- Carril, A. F., Menéndez, C. G. and Navarra, A., 2005: Climate response associated with the Southern Annular Mode in the surroundings of Antarctic Peninsula: A multimodel ensemble analysis, *Geophys. Res. Lett*., 32, L16713, do i:10.1029/2005GL023581
- Chapin, F. S., III, *et al*., 200 5: Role of land-surface changes in Arctic summer warming, *Science*, **310**, 657–660
- Curran, M. A. J., van Ommen, T. D., Morgan, V. I., Phillips, K. L. and Palmer, A. S., 2004: Ice core evidence for 20% decline in Antarctic sea ice extent since the 1950s, *Science*, **302**, 1203–1206
- Delworth, T. L., Ramaswamy, V. and Stenchikov, G. L., 2005: The impacts of aerosols on simulated ocean temperature and heat content in the twentieth century, *Geophys. Res. Lett*., **32**, L24709, doi:10.1029/2005GL024457
- Delworth, T. L., and Dixon, K. W., 2006: Have anthropogenic aerosols delayed a greenhouse gas-induced weakening of the North Atlantic thermohaline circulation? Geophys. Res. Lett., 33, L02606, doi:10.1029/2005GL024980
- Dupont, T. K., and Alley, R. B., 2006: Role of small ice shelves in sea-level rise, *Geophys. Res. Lett*., **33**, L09503, doi:10.1029/2005GL025665
- Fischetti, M., 2001: Drowning New Orleans, *Scientific American*, October, 68-77
- Fyfe, J. C., 2003: Extratropical Southern Hemisphere cyclones: Harbingers of climate change?, *J. Clim*., **16**, 2802–2805
- Fyfe, J. C., and Saenko, O. A., 2006: Simulated changes in the extratropical Southern Hemisphere winds and currents, *Geophys. Res. Lett*., **33**, L06701, doi:10.1029/2005GL025332
- Heath, J., Ayres, E., Possell, M., Bardgett, R. D., Black, H. I. J., Grant, H., Ineson, P. and Kerstiens, G., 2005: Rising atmospheric CO_2 reduces sequestration of root-derived soil carbon, *Science*, **309**, 1711–1713
- Hegerl, G. C., Crowley, T. J., Hyde, W. T. and Frame, D. J., 2006: Climate sensitivity constrained by temperature reconstructions over the past seven centuries, *Nature*, **440**, 1029–1032
- Hoyos, C. D., Agudelo, P. A., Webster, P. J. and Curry, J. A., 2006: Deconvolution of the factors contributing to the increase in global hurricane intensity, *Science*, **312**, 94–97
- Intergovernmental Panel on Climate Change (IPCC), 2001: *Climate Change 2001: Synthesis Report—Contribution of Working Groups I, II and III to the IPCC Third Assessment Report*, 397 pp., Cambridge Univ. Press, New York (Available at http://www.ipcc.ch)
- Intergovernmental Panel on Climate Change (IPCC), 2007: *Climate Change 2007: Synthesis Report—Summary for Policymakers*. (Available at http://www.ipcc.ch)
- Kilronomos, J. N., Allen, M. F., Rillig, M. C., Plotrowski, J., Makvandi-Nejad, S., Wolfe, B. E. and Powell, J. R., 2005: Abrupt rise in atmospheric CO_2 overestimates community response in a model plant-soil system, *Nature*, **433**, 621–624
- Lawrence, D. M., and Slater, A. G., 2005: A projection of severe near-surface permafrost degradation during the 21st century, *Geophys. Res. Lett*., **32**, L24401, doi:10.1029/2005GL025080
- Marshall, G.J., Orr, A., van Lipzig N.P.M. and King, J.C., 2006: The impact of a changing Southern Hemisphere Annular Mode on Antarctic Peninsula summer temperatures, *J. Clim*., **19**, 5388-5404.
- Matthews, H. D., Weaver, A. J. and Meissner, K. J., 2005: Terrestrial carbon cycle under recent and future climate change, *J. Clim*., **18**, 1609–1628
- NASA, 2003: Vanishing ice, features, 7 May.(Available at: http://earthobservatory.nasa.gov/Study/vanishing/.
- NASA, 2005: Satellites continue to see decline in Arctic sea ice in 2005, news release, 28 Sept. (Available at http://nasa.gov/centers/goddard/news)
- NASA, 2006: Greenland ice loss doubles in past decade, raising sea level faster, news release, 16 Feb. (Available at http://earthobservatory.nasa.gov/Newsroom/NasaNews/2006/2006021621775.html)
- NSIDC, 2007: US National Snow and Ice Data Center. http://nsidc.org/news/press/2007_seaiceminimum/20070810_index.html
- Overpeck, J.T., Otto-Bliesner, S.J., Miller, G.H., Muhs, D.R., Alley R.B. and Kiehl, J.T., 2006: Paleoclimatic evidence for future ice-sheet instability and rapid sea-level rise, *Science*, **311**, 1747-1750
- Page, S. E., Siegert, F., Rieley, J. O., Boehm, H.-D. V., Jaya, A. and Limin, S., 2002: The amount of carbon released from peat and forest fires in Indonesia during 1997, *Nature*, **420**, 61–65
- Pezza, A. B. and Simmonds, I., 2005: The first South Atlantic hurricane: Unprecedented blocking, low shear and climate change, *Geophys. Res. Lett*., **32**, L15712, doi:10.1029/2005GL023390
- Pittock, A.B., 2003: *Climate Change: An Australian Guide to the Science and Potential Impacts*. Australian Greenhouse Office, Canberra. See: www.greenhouse.gov.au/science/pubs/science-guide.pdf
- Pittock, A.B., 2008: Ten reasons why climate change may be more severe than projected. Chapter 1 in: *Sudden and Disruptive Climate Change*, ed. M.C. MacCracken, F. Moore and J.C. Topping Jr.., Earthscan, London, , pp. 11-27
- Rahmstorf, S., Cazenave, A., Church, J. A., Hansen, J. E., Keeling, R. F., Parker, D. E. and Somerville, R. C. J., 2007: Recent Climate Observations Compared to Projections, *Science*, **316**, 709
- Raupach, M., Briggs, P., King, E., Schmidt, M., Paget, M., Lovell, J. and Canadell, P., 2006: Impacts of decadal climate trends on Australian vegetation, paper presented at the Earth Observation Symposium, CSIRO, Canberra, 15-16 February 2006
- Ridley, J. K., Huybrechts, P., Gregory, J. M. and Lowe, J. A., 2005: Elimination of the Greenland Ice Sheet in a high CO_2 climate, *J. Clim*., **18**, 3409–3427

- Rotstayn, L. D., Cai, W., Dix, M. R., Farquhar, G. D., Feng, Y., Ginoux, P., Herzog, M., Ito, A., Penner, J. E., Roderick, M. L. and Wang, M., 2006: Have Australian rainfall and cloudiness increased due to remote effects of Asian anthropogenic aerosols?, *J. Geophys. Res.*,**112**, D09202, doi:10.1029/2006JD007712
- Scheffer, M., Brovkin, V. and Cox, P. M., 2006: Positive feedback between global warming and atmospheric CO_2 concentration inferred from past climate change, *Geophys. Res. Lett.*, **33**, L10702, doi:10.1029/2005GL025044
- Schellnhuber, H. J., Cramer, W., Nakicenovic, N., Wigley, T. and Yohe G. (Eds.), 2006: *Avoiding Dangerous Climate Change*, Cambridge Univ. Press, New York. (Available at http://www.defra.gov.uk/environment/climatechange/internat/dangerous-cc.htm)
- Serreze, M.C. and Francis, J.A., 2006: The Arctic on the fast track of change. *Weather*, **61**, 65-69
- Thomas, R., Frederick, E., Krabill, W., Manizade S. and Martin, C. 2006: Progressive increase in ice loss from Greenland, *Geophys. Res. Lett.*, **33**, L10503, doi:10.1029/2006GL026075
- Walsh, K. J. E., Nguyen, K.-C. and McGregor, J. L., 2004: Fine-resolution regional scale model simulations of the impact of climate change on tropical cyclones near Australia, *Clim. Dyn.*, **22**, 47–56
- Wang, S., Trishchenko, A.P., Khlopenkov K.V. and Davidson, A., 2006: Comparison of International (sic) Panel on Climate Change Fourth Assessment Report climate model simulations of surface albedo with satellite products over northern latitudes, *J. Geophys. Res*, **111**, D21108, doi:10.1029/2005JD006728
- Wild, M., Gilgen, H., Roesch, A., Ohmura, A., Long, C. N., Dutton, E. G., Forgan, B., Kallis, A., Russak, V., and Tsvetkov, A., 2005: From dimming to brightening: Decadal changes in solar radiation at Earth's surface, *Science*, **308**, 847–850

Résumé

Le Groupe d'experts intergouvernemental sur l'évolution du climat (GIEC) a finalement reconnu en 2007 que les humains sont la cause du problème du changement climatique. Les preuves que le monde se réchauffe sont très nombreuses, mais à quelle vitesse et quels en seront les impacts sont des questions qui demeurent ouvertes à la spéculation. Les 10 éléments de preuves présentés dans cet article supposent que le changement climatique survient plus rapidement que prévu. D'un point de vue global, la perspective est effrayante et il est probable que nous soyons confrontés à de graves conséquences dépassant toute compréhension actuelle. Le moment d'agir à tous les niveaux est aujourd'hui et maintenant. Les jardins botaniques ont une profonde compréhension de l'impact du changement climatique sur la diversité végétale. Ceci doit être clairement formulé haut et fort aux millions de personnes qui visitent chaque année les jardins botaniques.

Resumen

El Grupo Intergubernamental de Expertos sobre el Cambio á (IPCC) finalmente reconoció en el 2007 que el ser humano es la causa del cambio climático. Abunda la evidencia que la temperatura del mundo aumenta, pero aun se especula sobre a que ritmo y con que posible impacto. Las 10 áreas de evidencia que se presentan aquí indican que el cambio climático está ocurriendo a una velocidad mas elevada de la anticipada. Si se consideran colectivamente, el prospecto es alarmante y es probable que habrán resultados mas serios de los que actualmente podemos comprender. Esta es la hora de tomar acción a todos los niveles. Los jardines botánicos tienen un profundo conocimiento del impacto del cambio climático sobre la diversidad vegetal. Esto se tiene que proclamar con fuerza y claridad a los millones que visitan los jardines botánicos cada año.

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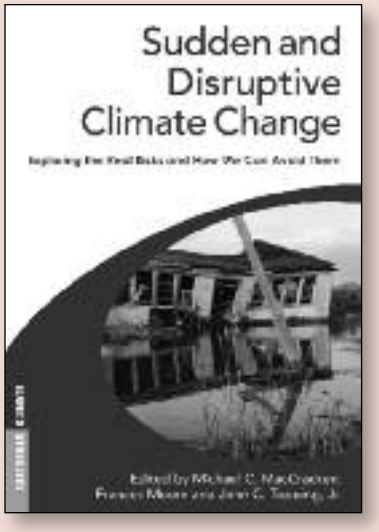

MacCracken, M. C., F. Moore, and J. C. Topping, Jr. (editors), 2008: *Sudden and Disruptive Climate Change: Exploring the Real Risks and How We Can Avoid Them*, Earthscan Publishers, London, UK, 320 pp.
www.earthscan.co.uk

La chaleur monte en Afrique – jardins botaniques, éducation et changement climatique

Se calienta la cosa en África – los jardines botánicos, la educación, y el cambio climático

Nopasika Malta Qwathekana and G. Midgley

The heat is on for Africa

botanic gardens, education and climate change

Summary The human impact on the composition of the atmosphere has resulted in an alarming increase of greenhouse gases, causing an increase of heat trapped and kept in the atmosphere and the penetration of the harmful ultraviolet rays of the sun due to the deterioration of the ozone layer. The consequence of all these atmospheric processes has resulted in an increase of global temperature which is commonly known as global warming and which is resulting in global climate change (Gates, 1993). As Bargagli (2004) also indicated, there is a global notable change in rainfall patterns, a shift in seasons, and a change in average temperatures to a point where life forms in all trophic levels (from vegetation, insects, animals, to human beings) are being threatened. Scorching heat is resulting in the destruction of vegetation; shifting seasons are confusing the agricultural sector and impacting on food production with subsistence farmers in developing and underdeveloped countries suffering the most.

Millions of people in Africa live below subsistence levels. They are heavily reliant on natural resources for their livelihoods yet their actions are causing deforestation and desertification. Botanic gardens in South Africa are at the forefront of biodiversity conservation and their work is directly relevant to the future sustainability of the country. This article will look at the effect of climate change on food security in developing and underdeveloped countries and examine the contribution botanic gardens are making, through education, lobbying and policy development, to averting the catastrophic effects of global climate change.

Right: SANBI environmental educators work with local communities to help them establish water-wise gardens (Photo: SANBI)

Why has climate change become such a widely discussed issue?

Evidence suggests that both poor and rich people in developed and underdeveloped countries are responsible for the deterioration of the environment. As a consequence we are witnessing an increase in temperatures, a major shift in seasons (http://news.bbc.co.uk/1/hi/sci/tech/5279390.stm) and a global change in climatic conditions.

For many of us, climate change has only recently emerged as a topic of discussion on the world stage. However, concerns about global warming have been voiced by scientists for many years, leading in 1988 to the establishment of the Intergovernmental Panel on Climate Change (IPCC), an international panel of scientists and policy makers. In 1990, the IPCC produced its first report on the potential risks of climate change. This same panel has now produced three further reports, one roughly every six to seven years, the latest of which has established a high level of confidence (>90% chance) that there is a link between human activities, global warming and climate change (IPCC, 2007).

To understand why climate change is a threat to human society it is necessary to understand our distant history. Human society only developed to our current levels of sophistication once the earth's temperature warmed (about 9,000 years ago) to the levels we have today. For a hundred thousand years before this, the earth was very cold.

People survived as hunter-gatherers and often as migrants. Life was very tough for our forebears. About 15,000 years ago the world began to warm. We know enough, however, to understand that changes in the amount of energy received from the sun, combined with changes here on earth (such as changing responses of living ecosystems) probably caused the earth to warm and then stabilise about 9,000 years ago (IPCC, 2007). The insight from this knowledge is that we live on a planet that is already warm in relation to the past, and that the relative stability of climate sustains complex societies, in comparison to the conditions of the past several million years!

Why are we worried about the future of climate change?

Firstly, we now know that the luxury of getting energy from coal and oil, and thus reducing the need for our own physical work, has a definite downside. In the process of burning coal and oil, we release thousands of tons of an invisible and odourless gas, carbon dioxide (CO_2), into the atmosphere (IPCC, 2007 WG1 chapter 7). The more we add, the more the world warms, but it takes several decades for the warming effect to show up in the atmosphere. This is a significant problem to manage, and very relevant to our children and grand-children. The warming that may occur will take the earth to temperatures not seen in many thousands of years (IPCC, 2007 Summary for Policy Makers), with consequences that are very difficult to predict. What is obvious, though, is that this could be a dangerous practice, and it is probably irresponsible to continue with it until we understand the consequences more fully.

The consequences include a change in the earth's rainfall patterns, such as increasing drought and floods, shifting patterns of where and when rain falls (IPCC, 2007 WG1 chapter 10), which will disrupt cropping and livelihoods, and rising temperatures that affect a host of human concerns, such as health (increasing numbers of insects and vector-borne diseases such as malaria), disaster management, sea level rise, land-use, agriculture, water supply, settlements, wild resources, wildfires and much more (IPCC, 2007 WG2).

What does this mean for Africa?

The impacts on Africa are generally expected to be worse on average than for the rest of the world, not only because of the changes projected, but also because of the generally low capacity for adaptive responses, coupled with the impacts of many other stresses on African societies (IPCC, 2007 WG2 Chapter 9). In South Africa, we have already seen many regions, especially the Western Cape, warming by roughly one degree centigrade over the past 30 years (Warburton et al 2005). Regional projections of rainfall change suggest that the Western Cape may suffer a 20% or more reduction in winter rainfall by the end of this century. Indeed there is even evidence of damaging effects of a regional climate shift on one of our iconic desert tree species, the Kokerboom (*Aloe dichotoma*), with populations dying back in parts of Namibia and South Africa (Foden *et al*. 2007).

Unfortunately, there is no scientific consensus on projected changes in rainfall in the summer rainfall regions (IPCC, 2007 WG1 Chapter 11). Such a high degree of uncertainty is problematic for adaptation planning, making it essential to carry out risk assessments that include the possibility of both increases and decreases in rainfall! It is no small wonder then that the world has begun to sit up and take notice of this emerging threat that may be gradual, but may arrive unexpectedly with a vengeance.

What can be done?

Two main things are being done at the international level – firstly, there are negotiations underway under the United Nations (the UN Framework Convention on Climate Change, see www.unfccc.ch) that attempt to implement reductions in emissions of greenhouse gases, such as CO_2, in the developed countries of the world. Reducing emissions is referred to as mitigation of climate change. But the developing world is starting to play catch-up, and nations such as China will soon become the biggest emitters of these gases worldwide. The negotiations around this topic are now attempting to find a way for all nations to contribute to cutting greenhouse gas emissions in some way. For example, some countries with tropical forests contribute large emissions by cutting virgin forest, and it would help enormously if this practice could stop around the world, as it would eliminate roughly 20% of the greenhouse gas problem.

Above: Thanks to the SANBI education programme, Tambo Cultural Village is now planted with indigenous trees and plants (Photo: SANBI)

This is a very complex and difficult negotiation process, and we can only hope that nations can place individual priorities to some extent beneath the global good. South Africa for example, which stands to suffer some damages from climate change, has committed to following a positive path, and aims to address its greenhouse gas emissions patterns in a way that will not impact economic development.

The other strategy now being actively investigated is *adaptation* to climate change. If we accept that climate change will occur before we get the problem under control, then we need to prepare ourselves for the possible impacts that will result. For example, we can improve investment in disaster management plans and infrastructure if we believe that more disasters may occur. We can look at how human settlements are positioned in relation to rivers and streams to prevent flooding, or we can develop crops and agriculture practices that can cope with a warmer world.

Botanic gardens and their role in averting the catastrophic effects of global climate change

The South African National Biodiversity Institute (SANBI) manages a network of nine botanic gardens. These botanic gardens are used as displays for plant collections as well as education facilities. Education programmes for target audiences from all walks of life are developed and offered by environmental

education personnel stationed in each of the botanic gardens. These education programmes are either garden based or outreach greening programmes.

Garden based environmental education programmes
Learning programmes are designed around issues of concern such as global warming and the resultant global climate change, biodiversity conservation, and other general environmental management related issues. Target audiences are taught about the role of vegetation in absorbing greenhouse gases from the atmosphere through photosynthesis, as well as how human activities (such as deforestation and the clearing of vegetation as well as the use of fridges and motor cars) adversely affect our lives by contributing to global climate change.

Outreach greening programme
SANBI environmental educators go out to schools and communities and assist them in developing water-wise gardens using indigenous trees and plants. These low maintenance gardens are also used to educate target audiences and beneficiaries about:

- threatened, endangered, rare, and extinct tree and plant species
- the importance of trees in the neighbourhood and how to reintroduce and protect them
- the importance of groundcover and how it can be used for reclaiming bare land patches
- the effects of deforestation on weather conditions and global climate change
- the connection between climate change and vegetation and how deforestation, overgrazing and uncontrolled fires on the veld (high plains of South Africa) indirectly lead to desertification.

Greening of the Nation

Over one hundred million rands (approximately six million pounds) have been secured to expand outreach greening programmes in schools and communities throughout all nine provinces of South Africa, including those that do not have botanic gardens. This programme, Greening of the Nation (GoN), aims to green school yards and other public places such as churches, hospitals, clinics, police stations and municipal offices through planting. It also aims to develop community nurseries for people to gain easy access to trees and plants. Local people are trained in various life skills to help them obtain employment and this, in turn, helps minimise their impact on the forest and other natural resources. Target groups are also trained and encouraged through GoN to practice aforestation and claim bare patches, by planting ground cover vegetation. Thousands of schools and community projects have now been greened and this contributes to carbon sequestration and minimisation of global warming. Hundreds of thousands of trees have been planted in schools, houses, streets and other public spaces by people trained and employed in the programme.

Integration with the school curriculum and teacher professional development

The programmes run by SANBI's Environmental Education Unit in the botanic gardens are integrated within the national school curriculum, ensuring that environmental issues are incorporated in daily school programmes. This also helps nurture a pool of environmental champions that will think globally and act locally in combating global climate change (Yeld, 1997). SANBI encourages schools to set up 'mini botanic gardens' in their school yards and supports teachers to use them as outdoor classrooms by running workshops with and for them, visiting schools and providing onsite support and raising funds to sponsor them for studying environmental education in recognised tertiary institutions.

Policy contribution

SANBI plays a leading role in global climate change debates in South Africa. It also provides advice on development and implementation of environmental policies and advice on biodiversity conservation and management issues to the Minister of Environmental Affairs and Tourism. The National Environmental Management Biodiversity Act (10 of 2004) details the role of SANBI and the botanic gardens as a lead agent in biodiversity management and conservation policy development for the country.

Conclusion

There is much to be done, the future is uncertain. It will be crucial for South Africa to develop the inventive minds and skills to tackle this and similar changes into the future, for the benefit of present and future generations. Global warming and the resultant global climate change is a threat that can be combated if we adopt sustainable living lifestyles (Yeld, 1997) and avoid activities that result in environmental degradation. Although the National Botanical Gardens in South Africa contribute in various ways to combating global climate change - by reintroducing the green canopy through GoN and outreach greening programmes, educating target audiences in all walks of life on principles for a sustainable living, contributing to policy formulation and inspiring and empowering people on how to care for their environments in general - a lot of collective actions by various stakeholders from various parts of the world is required if global positive results are to be achieved.

References

- Bargagli, R., 2004, Environmental Contamination, Climate Change and Human Impact, *Ecological Studies*, Vol. 175, Siena, Springer
- Foden, W, Midgley, G.F., Hughes, G., Bond, W.J., Thuiller, W., Hoffman, M.T., Kaleme, P., Rebelo, A.G., Hannah, L., 2007, Namibia desert trees feel the heat of climate change. *Diversity and Distributions* 13:645–653
- Gates, D.M., *Climate Change and its Biological consequences*, Sunderland, Mass: Sinauer Associates
- Humphreys, D., 1996, *Forest Politics: The Evaluation of International Cooperation*, London: Earthscan Publications Ltd
- IPCC, 1990, *IPCC First Assessment Report (1990): Scientific Assessment of Climate Change. Contribution of Working Group I* to the Intergovernmental Panel on Climate Change, J.T. Houghton, G.J. Jenkins and J.J. Ephraums, Eds., Cambridge University Press, Cambridge, 365 pp
- IPCC, 2007, Fourth Assessment Reports of Working groups 1, 2 and 3 (downloadable at www.ipcc.ch)

- IPCC, 2007, WG1: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge
- IPCC, 2007, WG2: *Climate Change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group 2 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge
- Republic of South Africa, 2004, *National Environmental Management: Biodiversity Act No. 10 of 2004*, Cape Town, South Africa
- Warburton, M, Schulze, R.E. & Maharaj, M., 2005, Is South Africa's temperature changing? An analysis of trends from daily records, 1950-2000. Chapter 16 in *Climate change and water resources in southern Africa. Studies on Scenarios, Impacts, Vulnerabilities and Adaptation*. Ed. Schulze. R.E., Water Research Commission Report 1430/1/05
- Yeld, J., 1997, *Caring for the Earth, South Africa, A guide to a sustainable Living*, WWF-SA, Stellenbosch, South Africa

Résumé

L'impact humain sur la composition de l'atmosphère s'est traduit par une augmentation alarmante des gaz à effet de serre, entraînant une augmentation de la chaleur piégée et conservée dans l'atmosphère ainsi que la pénétration des rayons ultraviolets néfastes du soleil due à la dégradation de la couche d'ozone. La conséquence de tous ces processus atmosphériques s'est manifestée par une élévation globale de la température, plus connue sous le nom de réchauffement planétaire et impliquant un changement climatique mondial. En Afrique du Sud, il se produit un net changement du cycle des précipitations, une altération des saisons, et une modification des températures moyennes à tel point que les formes de vie à tous les niveaux trophiques (depuis la végétation, les insectes, les animaux, jusqu'aux êtres humains) s'en trouvent menacées. La canicule provoque la destruction de la végétation ; le changement des saisons déroute le secteur agricole et affecte la production alimentaire, les petits paysans des pays sous-développés et en voie de développement étant les premiers à en souffrir.

Des millions de gens en Afrique vivent en-dessous du minimum vital. Ils dépendent fortement des ressources naturelles pour leur subsistance, toutefois leurs actions engendrent la déforestation et la désertification. Les jardins botaniques d'Afrique du Sud se trouvent au premier plan de la conservation de la biodiversité et leur travail est directement en lien avec la viabilité future du pays. Cet article étudie les effets du changement climatique sur la sécurité alimentaire dans les pays sous-développés et en voie de développement, et examine la contribution apportée par les jardins botaniques par le biais de l'éducation, du lobbying et de la mise en place de politiques, pour éviter les effets catastrophiques du changement climatique planétaire.

Resumen

El impacto humano sobre la composición de la atmósfera ha resultado en un aumento alarmante de los gases de invernadero, a la vez causando un aumento en el calor atrapado en la atmósfera y de la penetración de los rayos ultravioletas dañinos como resultado del deterioro de la capa de ozono. El resultado de todos estos procesos atmosféricos ha sido el aumento de la temperatura global, lo cual está resultando en el cambio climático. En Sudáfrica, hay un notable cambio en la distribución de la lluvia, un desplazamiento estacional, y un cambio en las temperatures medias hasta el punto que las formas de vida en todos los niveles (desde la vegetación, los insectos y otros animales hasta el ser humano) están amenazados. El calor abrasador está quemando la vegetación; el deplazamiento estacional confunde al sector agrícola e impacta sobre la producción de alimentos de tal manera que son los agricultures de subsistencia en los paises en desarrollo o sub-desarrollados los que sufren más.

Millones de personas en África viven por debajo del nivel de subsistencia. Dependen sobre todo en los recursos naturales para sobrevivir, pero sus propias acciones están causando la deforestación y la desertificación. Los jardines botánicos en Sudáfrica estan al frente de la conservación de la biodiversidad y su trabajo es directamente relevante a la futura sostenibilidad del país. Este artículo estudia el efecto del cambio climático sobre la seguridad alimenticia el los paises en desarrollo o sub-desarrollados y examina la contribución de los jardines botánicos a través de tales aspectos como la educación, las representaciones y el desarrollo de tácticas, y el evitar los efectos catastróficos del cambio climático global.

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Left: Hundreds of thousands of trees have been planted in schools, houses, streets and other public spaces by people trained and employed in the Greening of the Nation programme (Photo: SANBI)

Des choix difficiles – réinventer le monde moderne pour qu'il soit compatible avec la nature

Elecciones difíciles – reinventando el mundo moderno para que sea compatible con la naturaleza

Sarah Kneebone

Hard choices

reinventing the modern world so that it is compatible with nature

Summary An unusual partnership, between the Still Pictures worldwide picture library network and botanic gardens, has produced a global renaissance for Bob Dylan's haunting lyrics over the past couple of years. Dylan's poetry has formed the inspiration for 'Hard Rain: Our Headlong Collision with Nature' an outdoor exhibition, slide show, talk and photo reportage book illustrating the world's major environmental and social issues. Millions of visitors have now viewed the lyrics, each line interpreted by a dramatic, beautiful or shocking photograph. The creator of the exhibition, and founder of Still Pictures, Mark Edwards, has been thrilled with the response the exhibition has had from botanic gardens saying, "botanic gardens are ideal sites for the exhibition, as conservation organisations and pieces of nature in predominantly urban landscapes, they illustrate the essence of the exhibition".

Right: Forest clearance, Bangladesh (Photo: Gil Moti/ Still Pictures)

"I saw a black branch with blood that kept drippin',
I saw a room full of men with their hammers a-bleedin',
I saw a white ladder all covered with water,
I saw ten thousand talkers whose tongues were all broken,
I saw guns and sharp swords in the hands of young children,
And it's a hard, and it's a hard, it's a hard, it's a hard,
And it's a hard rain's a-gonna fall."

Right: An extract from the lyrics of 'A Hard Rain's A-Gonna Fall' by Bob Dylan (Copyright Bob Dylan, Special Rider Music/Sony/ATV Music Publishing 1963, 1991)

Hard Rain – eliciting a response

Initially launched at the Eden Project, UK, in 2006, the Hard Rain exhibition has since been displayed in Helsinki University Botanic Garden, Finland; Royal Botanic Garden, Madrid, Spain; Royal Botanic Garden Edinburgh, Scotland; Vilnius University Botanic Garden, Lithuania; Royal Tasmanian Botanical Gardens, Australia and; Kirstenbosch National Botanical Garden, South Africa, among others.

The provocative display has elicited strong responses from visitors and garden staff alike; the images seem to strike a common chord, stimulating a range of emotions from empathy to shock and outrage in viewers. Ana Casino, Director of Atlantic Botanic Garden, Gijón, Spain, was delighted with the media and visitor attention the exhibition received,

"It has been a pleasure for us to host the exhibition. We have had such a huge and grateful response from our city citizens and visitors that we have delayed its removal as much as we could! We have had hundreds of

Left: 'In the next 24 hours, deforestation will release as much CO_2 emissions as 8 million people flying from London to New York'. Irene Khan, Secretary General, Amnesty International, AI Report, 2005 (Photo: John Maier/Still Pictures)

visitors coming to see the pictures …we also gave the visitors the opportunity to express their feeling and emotions resulting from the exhibition. They could write and hang their opinions up for others to see, or send them to us via our website ….as you can imagine, this has been one of our biggest and most successful items in our latest calendar of activities".

Dr Gert Ausloos, Head of Education at the National Botanic Garden of Belgium was similarly pleased, *"In October and November (2007), more than 17,000 people visited the Garden and saw the exhibition. During the Belgian week of Sustainable Development the Garden organised staff activities where staff were asked to pick one picture that they found particularly striking, read the comment and reflect on their own work behaviour in the Garden. We encouraged them to link everyday actions like closing doors between glasshouses and including provoking images of the 'Hard Rain' exhibition in their email correspondence".*

Finding solutions

A second edition of Hard Rain was published in November 2007, to include four essays written by key figures in the environmental and political movement and over 50 new photographs by Mark. The book was sent to every prime minister and president in the world with a request that they suggest existing 'living solutions' from their country that could be adopted more widely as ways to combat the problems of climate change, poverty, population, habitat loss, species extinction and pollution, illustrated by Hard Rain. Their answers will now form the basis of another exhibition, 'Remaking a World Gone Wrong'. "This exhibition is intended to encourage people around the world to participate in bringing about a sustainable future and thus help provide governments with a constituency to produce policies that give companies the sort of predictability they need to invest in ever-cleaner technologies." explains Mark, he continues "The exhibition's main message is that we need to reinvent the modern world so it is compatible with nature. We urgently need to switch to renewable energy, new transport and production techniques and to create sustainable cities and rural communities if we are to meet the challenges illustrated in Hard Rain".

Above: 'Our small acts of pollution lack the awful drama of the oil spill that trapped this poor bird but, taken together, they are far more destructive to the planet' Fred Pearce, 2007 (Photo: D. Rodrigues/ UNEP/Still Pictures)

Remaking a World Gone Wrong

Partnered by UNEP and Still Pictures, 'Remaking a World Gone Wrong' will be announced at the UN Headquarters in May 2008. The Hard Rain team is hoping to launch the exhibition itself, with the complementary book and

Left: The Hard Rain exhibition at the Royal Botanic Garden, Edinburgh, Scotland (Photo: RBG Edinburgh)

Right: Clearcut logging, USA (Photo: Daniel Dancer/Still Pictures)

website, in 100 sites worldwide in 2010. It is envisaged that 'Remaking a World Gone Wrong' will be in two parts:

1) Living Earth
Part one will include pictures by the world's leading nature and reportage photographers to show how a great variety of natural systems interact to maintain stable conditions for life in all its forms. Since the industrial revolution, unsustainable technologies and an unprecedented increase in human population have damaged nature's ability to renew itself and sustain life. 'Living Earth' will feature a specially commissioned photo essay illustrating the conservation work undertaken by botanic gardens and zoos and introduce the concept of ecosystem services, demonstrating our dependence on natural systems. It ends by showing that the interaction between humankind and nature has a deeper, life-enhancing significance that lies at the heart of our environmental concern.

2) Living Solutions
Part two will illustrate 'Living Solutions' from around the world that need to be urgently and dramatically scaled up in order to 'futureproof' humanity and nature. These examples of sustainable practice recommended by presidents and prime ministers, mayors and business leaders will be presented so that visitors can adopt and campaign for solutions they would like to benefit from in their country or community.
A key section deals with climate change and shows how deep cuts in greenhouse gas emissions urgently recommended by the IPCC can be made with existing technologies.
It focuses on the post-carbon lifestyle future generations will be living if we are to avoid a climate cataclysm. Included here are the renewable energy technologies, clean transport systems and production techniques that will replace the heavily polluting systems which mankind has relied on to date.

Mark feels that the use of photographs is a vital part of the exhibition's success "The beauty of photography is that it allows you to bring the intellect and feelings together. There is no obstacle to people looking at photos

Right: Children scavenge rubbish from Manila Bay, Philippines. It will be sold through a chain of dealers and eventually recycled (Photo: Harmut Schwarzbach/U NEP/Still Pictures)

Left: 'Surui Amazonian children watch a bulldozer cut a logging road through their reservation, (Photo: Brazil Still Pictures)

which might be the case with paintings". He adds that they hope to inspire action with 'Remaking a World Gone Wrong' by capitalising on the strong emotions 'Hard Rain' has provoked in visitors, "Unless exhibitions affect people emotionally they will be forgotten. People will not change unless their heart and mind is involved. We need the excitement, the draw and impetus that this exhibition brings, to encourage people to be part of the change. Remaking a World Gone Wrong will have a huge impact".

Résumé

Un partenariat inhabituel entre Still Pictures, réseau mondial de banques d'images, et les jardins botaniques a engendré depuis ces deux dernières années une renaissance mondiale pour les paroles des chansons de Bob Dylan qui trottent dans nos têtes.
La poésie de Dylan a servi d'inspiration pour « Hard Rain: Our Headlong Collision with Nature », une exposition de plein air avec montages diapositives, discussions, livres de photo-reportages, illustrant quelques-uns des principaux problèmes environnementaux et sociologiques mondiaux. Des milliers de visiteurs ont déjà vu les paroles des chansons, chaque ligne étant illustrée d'une photographie dramatique, belle ou choquante. Mark Edwards, le créateur de l'exposition et le fondateur de Still Pictures, a été ravi des réactions suscitées par cette exposition dans les jardins botaniques. « Les jardins botaniques sont des lieux idéaux pour l'exposition. En tant qu'organismes de conservation et parcelles de nature dans des paysages principalement urbains, ils illustrent l'essence de l'exposition ».

Resumen

Una asociación entre la principal libreria de fotografías a nivel mundial Still Pictures y los Jardines Botánicos, ha producido un renacimiento global para la lírica de Bob Dylan's durante los ultimos años. La poesia de Dylan ha sido la inspiración para 'Hard Rain: Our Headlong Collision with Nature', una exhibición al exterior, proyección de diapositivas, plática y libro de fotorreportaje, que ilustra algunos de los mayores temas ambientales y sociológicos. Miles de visitantes han visto hasta ahora las poesias, cada línea interpretada por una fotografia dramática, hermosa e impactante.
El creador de la exhibición y fundador de Still Pictures, Mark Edwards, esta impresionado con la respuesta que la exhibición ha tenido desde los jardines botánicos. "Los jardines botánicos son sitios ideales para la exhibición, como organizaciones de la conservación y piezas de la naturaleza en paisajes predominantenmente urbanos, ellos ilustran la esencia de la exhibición".

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The Hard Rain Project is looking for more sites to host the 'Hard Rain' exhibition and the upcoming 'Remaking a World Gone Wrong'. If you are interested please contact:

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Left: 'Boy in front of an illegally logged ironwood tree, Nigeria (Photo: Still Pictures)

Jennifer Schwarz, Kayri Havens, Pati Vitt

Understanding climate change through citizen science

Summary This article will discuss two complimentary initiatives at the Chicago Botanic Garden. Both are designed to provide a positive and active context in which people can understand climate change and its impacts by contributing to ongoing citizen science projects. Phenology, or the study of plant life cycle events such as first flower, first leaf, and peak flower, provides an ideal context for these projects because it is a tangible, comprehensible, and ubiquitous process. Project BudBurst is a U.S. based citizen science initiative developed as a collaborative effort by the Chicago Botanic Garden and multiple universities that are members of the U.S. National Phenology Network (NPN). It engages citizen scientists of all ages, including youth, in recording phenological observations on the project website (www.budburst.org). A second related project, currently in the planning stage, is a national network of Climate Change Monitoring Gardens. These gardens will be connected by interactive exhibits at botanic gardens across the U.S. Their displays will consist of a standardised garden of genetically-identical cloned plants, internet connected computers with national data and analysis tools, and interpretive signage. Visitors will be able to observe phenological events at their current location, compare them to gardens at other locations, enter their own data into the website database, and register for a list-serve that will provide ongoing updates on the progress of both the Climate Change Monitoring Gardens and Project Budburst.

Introduction

In 2007, the Intergovernmental Panel on Climate Change reported that it was virtually certain that the climate is changing as a result of human activity (IPCC, 2007). This finding, though not a surprise to most scientists, was startling to much of the general public. While the release of the IPCC report provided a needed boost in awareness, it also highlighted three challenges facing environmental education institutions. First, the report was accompanied by the mass distribution of simplified and inaccurate information by the media (Ladle, Jepson and Whittaker, 2005). Second, there is an overall lack of specific information on actions individuals can take to mitigate climate change (Lowe *et al*., 2006). Finally, because the impacts of climate change are not yet obvious in most regions of the U.S. it is seen as secondary to immediate issues in people's lives (Lorenzoni and Pidgeon, 2006). These three conditions create a context in which individuals are not inspired, motivated, or equipped to take action to mitigate climate change.

From casual observer to citizen scientist

Project BudBurst and the Floral Report Card, developed by the Chicago Botanic Garden and its collaborators, are two complimentary initiatives designed to provide a positive and active context in which people can understand climate change and its impacts by contributing to ongoing citizen science projects. Both projects were developed with the intention of providing not only an on-site visitor experience, but also a range of engagement opportunities that continue after the initial garden or website visit. Research on engagement, motivation, and citizen science provided the context for programmes that 1) initially engage the casual observer, 2) motivate the observer to further investigation and, 3) provide a range of opportunities for action.

People tend to become engaged in issues with which they have personal experiences and that have immediate consequences in their everyday lives, while climate change is still perceived as a vague and distant threat (Dessail *et al*., 2003, MacDonald and Silverstone, 1992). However, everyone can make and understand observations about when plants sprout, bloom, and die. The study of these life cycle events, known as phenology, is an ideal context for engagement because it is a tangible, comprehensible, and ubiquitous process that provides a common context through which visitors can engage in a more complex understanding of science (Athman & Monroe 2002, Barnett *et al*., 2004). In order to motivate the observer to further investigation, both projects leverage interactive and web-based technologies that allow visitors to manipulate data, ask questions of their own design, and provide immediate ways to extend the museum experience beyond the one-time visit (Clark 2003, Pea & Gomez, 1992, Montada *et al*., 2007). Finally, by providing a range of opportunities for action that address climate change from a variety of perspectives and at different levels of commitment, individuals are able to choose the actions that best fit their interests and personal constraints.

Left: Project BudBurst provides a positive and active context in which people can understand climate change and its impacts by contributing to ongoing citizen science projects (Photo: Chicago Botanic Garden)

Floral Report Card

Specifically, the Floral Report Card, currently in development, is a network of 'climate change monitoring gardens' and exhibits that will be installed at five botanic gardens across the U.S. (Chicago Botanic Garden, IL; Garfield Park Conservatory. IL, Denver Botanic Garden, CO, University of Washington Botanic Garden, WA, and North Carolina Botanical Garden, NC). The gardens will include native species that:

- have wide geographic ranges
- have flowering times that are initiated by temperature, as opposed to day length
- are long-lived and exhibit a variety of breeding systems
- are easy to clone
- are attractive in a garden setting.

The target species will include *Baptisia australis* (False indigo), *Phlox paniculata* (Summer phlox), *Monarda fistulosa* (Bee balm), *Sorghastrum nutans* (Indian grass, a C4 grass), and *Pascopyrum smithii* (Western wheatgrass, a C3 grass). By holding the genetic variance constant and standardising the growing conditions, the gardens will act as a network of climate sensors. Plant responses to the different climates of the five participating gardens will allow visitors and researchers to make inferences about how the species might respond to future climate change.

The gardens will be connected by interactive, web-based exhibits that include regional and national data and analysis tools and interpretive signage. Visitors will be able to observe phenological events at their current location, compare them to gardens at other locations, enter their own data into the website database, and register for a list-serve that will provide ongoing updates on the initiative. Repeat photos will be displayed on a project website, enabling website visitors to see phenological changes and patterns through time, as well as across participating sites. The Floral Report Card is unique in its approach. It uses a current and compelling scientific issue to interest casual observers (Kolsto, 2000), allows visitors to interact with existing data, and most importantly, allows visitors to enter data they collect immediately into the web database through the computer kiosk at the exhibit. The visitor has an immediate way to participate in important scientific research that becomes a permanent part of the exhibit. By providing this opportunity, the Floral Report Card provides an incentive for continued participation. To support repeated contacts it offers 'on demand' follow up opportunities. Visitors can send the results of their on-site enquiries to themselves via email, and join an email list that provides updates on the progress of the Floral Report Card and opportunities to participate in other citizen science initiatives including Project BudBurst. While BudBurst is a stand alone initiative, it also represents an extension of the Floral Report Card that provides a straightforward way for individuals to contribute to research on climate change.

Project BudBurst

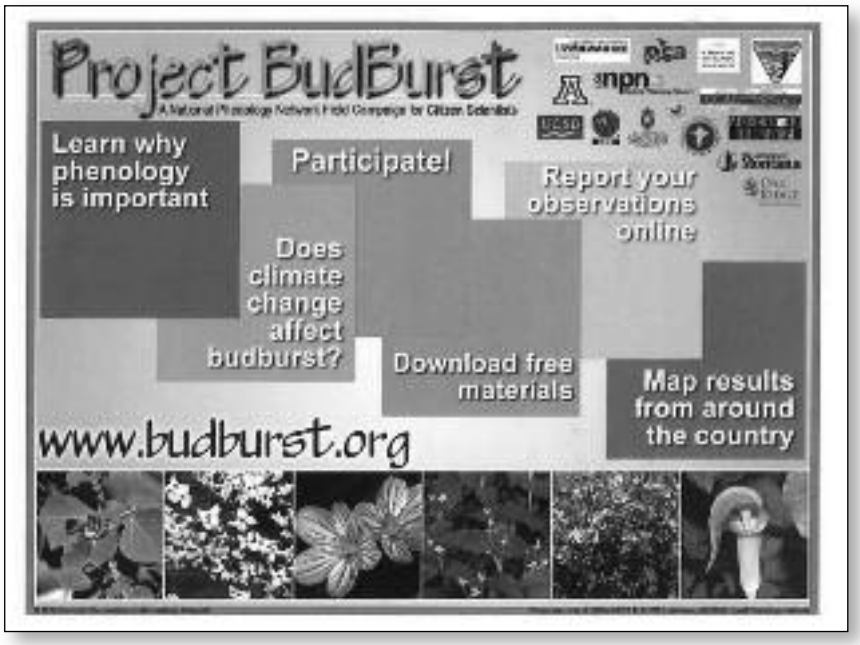
Project BudBurst, now in year two of implementation, is also a phenology-based programme that provides extended opportunities for individuals to contribute to research on climate change. This U.S. based citizen science initiative was developed as a collaborative effort by the Chicago Botanic Garden, the University Collaborative for Atmospheric Research, and multiple other members

of the U.S. National Phenology Network (NPN). Citizens are asked to observe local flora, whatever species exist in their backyard or community park, throughout the growing season and enter observations of phenological events into a web-form connected to the BudBurst database. The website includes detailed information on phenology, climate change, and plant identification, as well as guidelines for family, youth and in-school activities. It also contains detailed information on 60 native wildflowers, shrubs and trees. By using a context that people can relate to on a personal level – gardens and plant growth – and providing specific information on common species like the dandelion and lilac (in addition to natives), the Budburst website (www.budburst.org) accommodates all ages and locations. Participants are encouraged to continue participation by both immediate feedback and the visible accumulation of their data and ongoing contributions to the project.

The success of this approach is shown by the first year's data collection. In 2007 there were nearly 900 observations from 38 states, the majority submitted by children under 12. This last statistic is indicative of the project's accessibility and broad appeal. Teachers in particular, have expressed their excitement at the prospect that their students can participate in a meaningful research project that is adaptable to all ages and classroom styles and is relevant across disciplines. For year two, beginning February 2008, BudBurst has added a number of new features to the website that will facilitate ongoing participation. The site now accepts data all year round to accommodate people in warmer regions. Participants can also now create personalised 'MyBudBurst' pages which allow them to record and save the locations and plants they are observing and consolidate their data collection efforts. Personalisation not only provides a streamlined data collection process, but also brings the individual into a like-minded community, the existence of which has been shown to increase participation both in educational and extracurricular programmes (Harvard Family Research Program, 2004, Sherrod et. al., 2002). Finally, BudBurst is now accepting historical datasets (since many citizen scientists have volunteered to donate their datasets going back decades in some cases) to enhance the scientific usefulness of the project data.

Conclusion

Project BudBurst and the Floral Report Card were developed with the goal of addressing the challenges put forth by the IPCC in 2007. Phenology provides an entryway to a complex and controversial issue that can inspire and motivate individuals to investigate climate change beyond a one time garden or web site visit. Opportunities to contribute to the on site exhibits and immediate feedback on their interaction, as well as 'on demand' avenues to further communication provide ongoing reminders to visitors. Participants discover that they are able to make valuable contributions to a 'real' research project through the cumulative efforts of their and others' work. It is in this way that the Chicago Botanic Garden and its partners are reaching and engaging widespread audiences in environmental science at a critical time in our history.



Right: In it's first year Project BudBurst collected nearly 900 observations from 38 states (Photo: Chicago Botanic Garden)

References

- Athman, JA and Monroe MC., 2002, Elements of Effective Environmental Education Programs. *School of Forest Resources and Conservation*, University of Florida
- Barnett, M., Strauss E., Rosca, C., Langford, H., Chavez, D., Deni, L., Lord, C., 2004, Improving urban youth's interest and engagement through field-based scientific investigations. *Proceedings of the 6th International Conference of the Learning Sciences* p. 73-80. Santa Monica, CA
- Brossard, D., Lewenstein, B., & Bonney, R., 2005, Scientific knowledge and attitude change: The impact of a Citizen Science Project (A research report). *International Journal of Science Education*, 27, 1099 - 1121
- Clark, S A., 2003, Instructional Technology, Motivation, Attitudes and Behaviors. Universal Publishers
- Dessail Suraje, W., Adger, N., Hulme, M., Turnpenny, J., Köhlerand, J., Warren, R., 2004, Defining and Experiencing Dangerous Climate Change, *Climatic Change* V. 64, # 1-2 / May 2004 p. 11-25
- Harvard Family Research Project, 2004, Moving Beyond the Barriers: Attracting and sustaining youth participation in out-of-school time programs, *Issues and Opportunities in Out of School Time Evaluation*, No. 6, July 2004
- Kolsto, Stein D., 2001, Scientific Literacy for Citizenship: Tools for dealing with the science dimension of controversial issues, *Science Education*, Volume 85, Issue 3, pp 207 – 310

- Ladle, R., Jepson, P., Whittaker, R., 2005, Scientists and the media: the struggle for legitimacy in climate change and conservation science, *Interdisciplinary Science Reviews*, Vol. 30 No. 3 p.231-240
- Lorenzoni, I., and Pidgeon, N.F., 2006, Public Views on Climate Change: European and USA perspectives, *Climactic Change*, 77, 73-95
- Lowe, T., Brown, K., Dessai Suraje, W., de Franca Doria, M., Haynes, K., Vincent, K., 2006, Does tomorrow ever come? Disaster narrative and public perceptions of climate change, *Public Understanding of Science*. Vol. 15 No. 4 pp 435-457
- MacDonald, S., and Silverstone, R., 1992, Science on display: The representation of scientific controversy in museum exhibitions, *Public Understanding of Science*, Vol. 1, No. 1, 69-87 (1992)
- Montada, et. al., 2007, Willingness for Continued Social Commitment: A New Concept in Environmental Research. *Environment and Behavior*. 39 : 3. 287-316
- Pea, R.D., and Gomez. L. M., 1992, Distributed multimedia learning environments: why and how, *Interactive Learning Environments* 2:73-109
- Sherrod, L., Flanagan, C., and Youniss, J., 2002, Dimensions of Citizenship and Opportunities for Youth Development: The what, why, when, where and who of citizenship development, *Applied Developmental Science* Vol. 6, No. 4, 264-272
- United Nations Environmental Programme, 2007, Intergovernmental Panel on Climate Change Fourth Assessment Report, Climate Change 2007: Synthesis Report Valencia, Spain

Résumé

Cet article décrit deux initiatives proposées par le Jardin botanique de Chicago. Toutes deux sont conçues en vue d'apporter un contexte positif et actif grâce auquel le public est amené à comprendre le changement climatique et ses impacts, en participant régulièrement à des projets de science citoyenne. La phénologie, ou l'étude des stades du cycle de la vie végétale tels que la première fleur, la première feuille, et le pic de floraison, présente un contexte idéal pour de tels projets car il s'agit d'un processus tangible, compréhensible, et omniprésent.

Project BudBurst est une initiative de science citoyenne basée aux états-Unis et mise en place de manière collective par le Jardin botanique de Chicago et diverses universités membres du U.S.A. - National Phenology Network (NPN). Elle invite des scientifiques citoyens de tout âge, y compris les jeunes, à inscrire leurs observations phénologiques sur le site internet du projet (www.budburst.org). Un second projet lié au premier, et actuellement au stade de création, correspond à un réseau national de Jardins d'observation du changement climatique. Ces jardins seront associés par le biais d'expositions interactives dans différents jardins botaniques à travers les états-Unis. Ces expositions seront constituées de jardins standardisés composés de plantes clonées génétiquement identiques, d'ordinateurs connectés via Internet à la base de données nationale et aux outils d'analyse, et de panneaux d'interprétation. Le public pourra observer les stades phénologiques dans leur lieu actuel, les comparer aux jardins dans d'autres lieux, intégrer leurs propres données dans la base de données du site internet, et s'inscrire à une liste de diffusion qui donnera des actualisations tant sur l'évolution des Jardins d'observation du changement climatique que sur Project Budburst.

Resumen

En este artículo estudiamos dos iniciativas complementarias del Jardín Botánico de Chicago. Ambas iniciativas están diseñadas para proporcionar un marco positivo y activo dentro del cual el público pueda comprender el cambio climático y sus impactos, contribuyendo a la misma vez a los proyectos vigentes de ciencia ciudadana. La fenología, o el estudio de los ciclos de vida vegetal, tal como la primera flor, primera hoja o maxima floración, proporciona un contexto ideal para estos proyectos porque es un proceso tangible, comprensible, y ubicuo.

El proyecto "BudBurst" es una iniciativa estado-unidense de ciencia ciudadana desarrollada por el Jardín Botánico de Chicago en colaboración con multiples universidades miembros del U.S. National Phenology Network (NPN). Utiliza a los ciudadanos científicos de todas las edades, incluso a los jóvenes, para recoger datos fenológicos e incorporarlos en la página web del proyecto (www.budburst.org). Un Segundo proyecto, actualmente en fase de planificación, es una red nacional de jardines monitores del cambio climático. Estos jardines estarán enlazados por exposiciones interactivas a través de los Estados Unidos. Sus exposiciones consistirán de un jardín estandarizado de plantas geneticamente idénticas, ordenadores conectados por el internet con datos nacionales, herramientas para el análisis, y material de interpretación. Los visitantes podrán también observar los sucesos fenológicos en su localidad, compararlos con los jardines en otras localidades, contribuir sus propios datos al banco de datos en la web, y registrarse para recibir información para mantenerse al día sobre ambos proyectos.

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Instruire petit à petit: sensibiliser le public au changement climatique

Educando por grados: creando concienciación publica en cuanto a cambio climático

Luiza Chomenko, José Fernando Vargas, Elisabete Monlleo M. da Silva

Educating by degrees

raising public awareness about climate change

Summary Rio Grande do Sul is located in southern Brazil and contains some of the world's most important ecosystems, ranging from tropical forests in the north to savannah in the south. The impacts of global warming are marked throughout the state and this can be seen in the loss of agricultural land and changes in distribution of some species of plants and animals. The Zoological-Botanical Foundation in Rio do Sul (FZB) places great importance on raising awareness about the issues associated with global warming and runs a variety of activities with target audiences, mainly teachers and students. Activities include themed video presentations, lectures and discussions with teachers and professionals specialising in climate change. FZB is responsible for administrating Porto Alegre's Botanic Garden, which is a partner in this awareness campaign.

Right: Climate modeling demonstrates that biodiversity, farming and human settlements will be adversely affected by sea level rise in Rio Grande do Sul (Photo: FZB)

Introduction

Brazil is South America's largest country and almost certainly hosts the greatest degree of biodiversity on the entire planet. It contains six biomes, of continental proportions (the Amazon rainforest, the Cerrado, the Caatinga, the Pantanal, the Atlantic Forest and the Pampas) and ranks first in the world for numbers of species of mammals, freshwater fish and plants, second for amphibians, third for bird species; and fifth for species of reptiles (Lambertini, 2000).

Rio Grande do Sul is the southern most state of Brazil. Its territory is formed by the Atlantic Forest, which occurs throughout Brazil (from the south to the northeast), and the Pampas which is restricted to the southern half of the state. Its environmental riches, make Rio Grande do Sul one of the most prosperous states in Brazil and in particular, it is famous for its grain production and cattle rearing. Rio Grande do Sul is also well known for its Gauchos, natives of the state named after cattle herders and ranchers who settled in the Pampas regions.

Climate change and Rio Grande do Sul

Climate change has become an increasingly important topic for discussion in Rio Grande do Sul. Research and climate modelling carried out in Brazil demonstrates that Rio Grande do Sul will be adversely affected by sea level rise, particularly in relation to biodiversity, farming and human settlement along seaside and lagoon regions. Data is already revealing land loss and its consequences in the use of these regions. There are also indications of changes in the composition and range of native or migratory flora and fauna that come to the State at some stage during their life cycle.

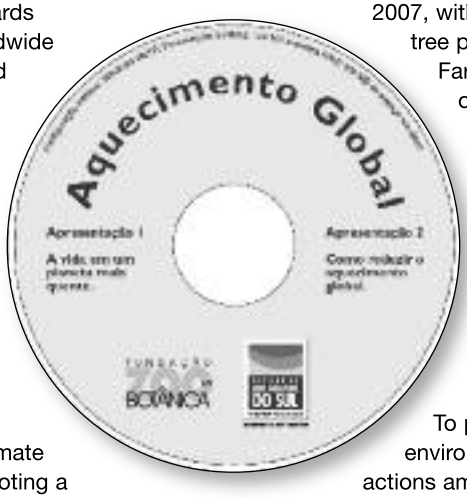
Global warming is of concern to everyone and its consequences to future generations demand an urgent change of attitude from the population. Politicians and business people are not the only ones responsible for this serious situation. We all are.

Since the United Nations Conference on the Human Environment in Stockholm 1972 and the world's first intergovernmental conference on environmental education in Tbilisi, 1977, there has been a growing world movement concerned with environmental issues. In Rio Grande do Sul, we have found that environmental education is proving to be an effective way to promote large public discussion and to allow internationally evaluated concepts to be broadened. In particular it 'generates a clear conscience, social and environmental independence, giving human beings the opportunity to gain knowledge, values and attitudes that allows them to change their behaviour patterns in order to protect and improve their environment' (Dios 2001). Through acknowledging values and concepts, environmental education promotes abilities and attitudes that understand and appreciate the natural and social relations between humans and their environment.

Left: Flyer explaining the contributions we can make to improving life on our planet (Photo: FZB)

Public awareness campaign on climate change

The Zoological-Botanical Foundation in Rio do Sul (FZB) is part of the State Environmental Department (SEMA), which administrates Porto Alegre's Botanic Garden, the Natural Science Museum and the Zoo. FZB works with different sectors of society to participate in many activities related to climate change. It also contributes towards developing worldwide strategies related to climate change in accordance to the National Climate Change Policies of Brazil.



Left: CDRom, produced as part of the public awareness campaign on climate change and distributed to state public schools (Photo: FZB)

In 2007, FZB initiated a public awareness campaign on climate change by promoting a series of environmental education actions through formal and non-formal processes. The campaign involved different departments of the institution, in partnership with other public and private institutions. The focus of the campaign was to show the importance of individual and collective contributions by each citizen, as well as to explain causes and consequences of climate changes. The first set of activities consisted of academic lectures and discussion meetings with students and teachers of state public schools. The campaign was officially launched during the state's Environmental Week, in July 2007, with a meeting and tree planting in Farroupilha Park, one of the largest parks of Porto Alegre, the State's capital, with the participation of politicians, hundreds of students, teachers and park visitors.

To promote environmental education actions among students and teachers, materials were produced including a CDRom and flyers explaining the contributions you could make to improving life on the planet. The CDRom consists of two elements:

1. *Life in a warmer planet* which looks at conceptual subjects, causes and consequences, emphasising that the problem of climate change is part of our everyday life and showing the reality already found in Rio Grande do Sul.
2. *How to reduce global warming* which provides suggestions of easy-to-follow actions to reduce global warming.

The materials were distributed to state public schools by the state's Education Office and are still being used in different events throughout the state. In recognition of the fact that teachers and educators will play a significant role in spreading the campaign, FZB ran a number of workshops to present the materials and activities that could be carried out in schools. A slogan contest was also developed with local schools as a strategy to improve the

Above: Porto Alegre Botanic Garden is located in Rio Grande do Sul, home to some of the world's most important ecosystems (Photo: FZB)

participation of students. 'Global warming: Our planet is sick. We are the cause and the solution' was created by a 13 year-old and chosen as the best slogan.

Conclusion

Running this campaign has demonstrated a high level of commitment that exists within many parts of society to resolving climate change. For example, public departments with professionals directly involved in the activities and private companies that contribute financially to supporting the activities and donate prizes to students and teachers. The campaign has been an enormous success and we believe that it can serve as a model for other institutions. Because this subject is highly relevant and critical, the campaign will continue and we will gather new partners and broaden its range to regions not yet involved.

References

- Brasil (2000) *Decreto nº 3615*, de 20 de junho de 2000 relativo a criação do Fórum Brasileiro de Mudanças Climáticas. http://www.mct.gov.br/index.php/content/view/4025.html Acessed 22 de janeiro de 2008.
- Brasil (2007) *Decreto nº 6263*, de 21 de novembro de 2007. CIM – Comitê Interministerial sobre mudanças do clima. http://www.dji.com.br:80/decretos/2007-006263/2007-006263.htm Acessed 22 de janeiro de 2008.
- Chomenko, L. (2007) Educação Ambiental na América Latina, in *III Seminário estadual e VI Seminário Regional de Educação Ambiental Saber Ambiental*. Santa Cruz do Sul, Brasil.
- Chomenko, L. (2007) Pampa: um bioma em risco de extinção, in *Ihu-on-line*(247), 5-8 http://www.unisinos.br/_ihu/uploads/publicacoes/edicoes/1197310511.65pdf.pdf Acessed 22 de janeiro de 2008.
- Dias, G. F. (2001) *Educação Ambiental: princípios e práticas*. Gaia, São Paulo Brasil.
- Lambertini, M. (2000) A Naturalist's Guide to the Tropics, University of Chicago Press
- Ricardo, C.A. , Campanili, M. (2004) *Almanaque Brasil Socioambiental*. Socioambiental, São Paulo Brasil.

Résumé

La situation géographique de Rio Grande do Sul au sud du Brésil est propice à la présence d'écosystèmes d'une importance mondiale. Par conséquent, différentes actions liées au réchauffement climatique et à ses interactions avec le quotidien se mettent en place dans l'état. Celles organisées par la Fundação Zoobotânica do Rio Grande do Sul (FZB) sont très importantes, notamment par la promotion d'activités auprès de différentes fractions de la société, surtout les enseignants et les étudiants, sur les places publiques, vidéo-projections à thèmes, conférences et discussions avec les enseignants et professionnels spécialistes de la problématique. La Fundação Zoobotânica do Rio Grande do Sul (FZB) gère le Jardin botanique de Porto Alegre, une institution qui prend part à cette campagne de sensibilisation.

Resumen

La situación geográfica de Rio Grande do Sul en el sur de Brasil hace que se encuentren en esa localidad algunos ecosistemas de importancia global. Por esta razón, se están realizando acciones sobre el aumento global de las temperaturas y su relación con la vida cotidiana. Las actividades organizadas por la Fundação Zoobotânica do Rio Grande do Sul (FZB) son de gran importancia, fomentando las actividades con varios elementos de la sociedad, sobre todo con profesores y estudiantes, en las plazas públicas, con presentaciones temáticas de video, charlas y debates con profesores y profesionales especializados. La Fundação Zoobotânica do Rio Grande do Sul (FZB) administra el Jardín Botánico de Porto Alegre, una insitución que participa en esta campaña de concienciación.

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Voilà le soleil – jardinage avec le temps

Aqui viene el sol – jardinería climática

Alison Darby

Here comes the sun

gardening with the weather

Summary In Spring 2006 Winterbourne Botanic Garden was awarded £10,000 by the UK government's Department for Environment, Food and Rural Affairs (Defra) as part of the their Climate Challenge project. Money was awarded to schemes that would raise people's awareness and understanding of climate change. The 'Working with the Weather' project was primarily aimed at adult visitors who were asked to make the connection between changes in their own garden and climate change. A model garden was designed to show what features could be incorporated in a domestic setting to help counter the effects of climate change. A leaflet including these ideas was produced to help visitors make changes to their own gardens.

Introduction

In recent years, there has been a significant increase in media coverage about climate change (Kalaugher, 2007). However, despite this, statistics from a government survey (Defra, 2001) revealed that males aged 18 – 24 and the over 65's in general admitted to knowing very little about climate change. Most interesting was that of the older age group questioned, nearly a third responded that they did not believe in climate change. This age group forms a large percentage of the visitors to Winterbourne Botanic Garden at the University of Birmingham, UK, a six acre Edwardian Arts and Crafts style garden on the university's Edgbaston Campus which is open mainly during weekdays. We believed that by creating a climate change garden we could make a real impact on this age range.

Starting out

In Spring 2006, Defra awarded us a grant of £10,000 which we matched with staff time. The project timeline was just over two years and the money was tight, but a focussed campaign targeting a specific group seemed the most effective way to use the grant. Our response to the challenge was to develop a programme in three phases.

We first asked visitors to make a connection between their experiences of extreme weather conditions in the garden and the cause of the conditions - climate change. Although we used the example of hotter, drier summers, we were careful throughout our information to refer to extreme weather conditions, rather than global warming. This decision proved to be a wise one as the second summer of the project was one of the wettest on record, resulting in one of our special talks about the project being rained off.

Phase 1

The first phase of the project ran for the summer of 2006 with a series of five A4 sized panels placed around the garden with the words 'Have you noticed . . . ?' on each one. Each panel featured a different kind of extreme weather and its effect on the garden. For instance, one panel asked if visitors had noticed whether they needed to continue mowing their lawn later in the year. The panel went on to explain that longer, milder winters were just one of the effects of climate change. By relating visitors own experiences to the effects of climate change we (hopefully) established that not only did the problem exist but that it was one which was already facing them. These panels were researched and designed in-house and to save money they were produced using Microsoft Publisher and our own heat press.

Phase 2

Once we had introduced the idea of climate change, we created the Phase 2 model garden area. Here we offered solutions for a domestic garden which

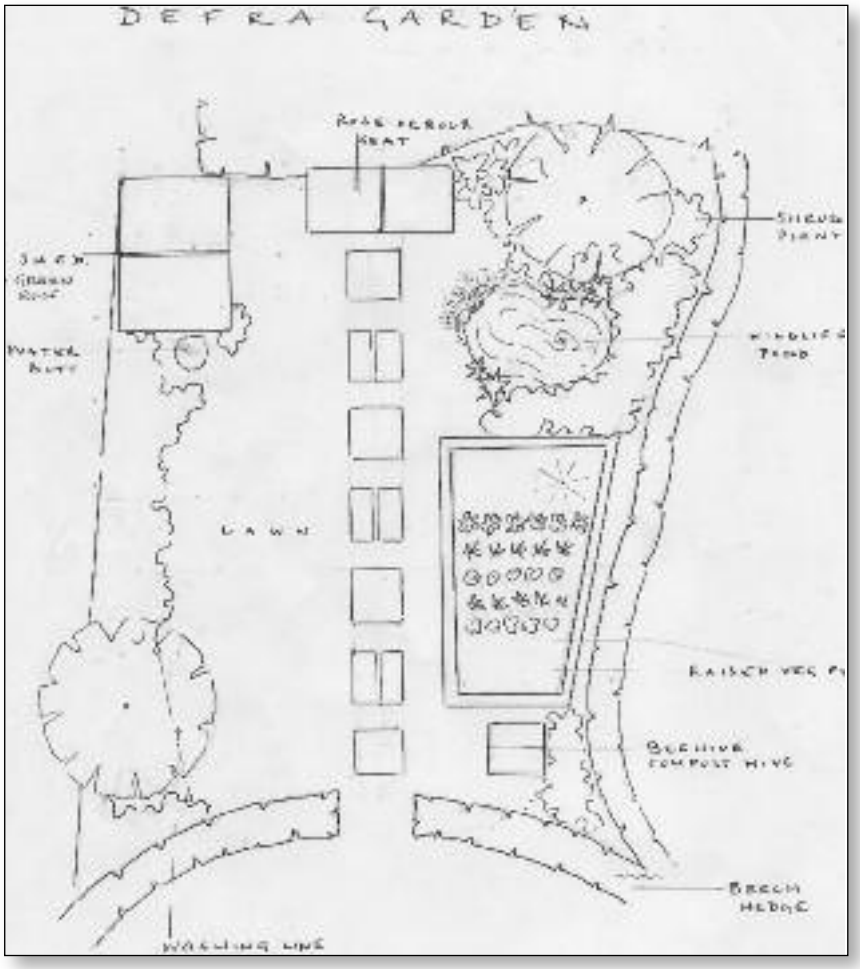
could help counter the current effects of climate change. Our aim was for visitors to understand how their actions could reduce further damage in the future. The garden was created in a previously under-used area of the main garden. It was contained on three sides so that the interpretation panels could play a large part in the area without impacting on the rest of the site. It was important to us that the garden was attractive in its own right as our target audience, the older generation, were sceptical about climate change.
To encourage the use of ideas offered in the garden, we created a space that visitors could relate to in terms of design and scale; ideas they could imagine in place in their own gardens.

There were five features in the model garden which demonstrated different ways to work with the weather. We felt this was the optimum amount of information for the space (which was only five by ten metres). The features did not demonstrate groundbreaking ideas; instead they offered simple explanations of why each of the features could help gardeners mitigate and adapt to the effects of climate change.

- Water butt – importance of saving rain water
- Compost Heap – recycling garden waste
- Wildlife pond – benefits of attracting wildlife
- Vegetable bed – benefits of growing your own produce
- Washing line – energy saving and benefits of outdoor drying
- Green roof on shed – creation of habitats and minimising water run off

The model garden was designed by our Head Gardener and all practical works were carried out by our staff. We also carried out the initial research and decided on the themes for each of the model garden boards.

Lessons learned from our first set of panels meant that the final text for the boards was put together by an interpretation specialist and the boards themselves were produced by a specialist company. Although we had been pleased with our first phase of the programme, it was felt that we could do more to get the message across and we simply did not have the required expertise in-house. This second phase process was much more enjoyable and we were excited to receive the final boards which used our ideas. Of all the monies spent, the majority went on these Phase 2 boards.



Right: Design for the model climate change garden, created by the Head Gardener at Winterbourne Botanic Garden (Photo: Winterbourne Botanic Garden)

Phase 3

Evaluation was carried out at strategic points during the project. Our first survey was distributed prior to any work on the project and was designed to find out general attitudes towards climate change. After the introduction of our Phase 1 panels we carried out a second survey where we asked the same questions and included some new open questions to discover any change in attitudes or behaviours. This feedback was used when deciding on the features for the model garden and on the themes for the boards. A third survey was distributed once the garden was in place to help us put together Phase 3 of the project, a leaflet of hints and tips to take home.

As a result of the survey we reduced the amount of information that we were offering. We kept returning to the main brief 'to raise people's awareness and understanding of climate change', although it was tempting to bombard visitors with ideas and suggestions we were concerned this may have frightened the visitors away from the subject. We are now coming to the end of the project and one of the benefits of our work with Defra is that we will still have a model garden which we can retain for as long as visitors show an interest.

Conclusions

A final survey will be carried out in May 2008 at the close of the project, but our feedback already shows that we have been successful in raising awareness of climate change. It must be said that the extreme weather conditions of 2007 did much to help convince our sceptics! Visitors have

taken our ideas leaflets away with them and only time will tell if they implement any of our ideas in their own gardens.

My final message would be that there is a role for smaller botanic gardens to play in helping to inform our audiences. Even though Winterbourne has no budget for an education officer or a formal education programme, this does not stop us finding ways to educate our visitors about the topics that are important to all of us.

References

- Defra, 2001, Survey of Public Attitudes to Quality of Life and the Environment. Online at http://www.defra.gov.uk/environment/statistics/pubatt/download/survey2001.pdf
- Kalaugher, L., 2007, Environmental Research Letters, Online at http://environmentalresearchweb.org/cws/article/opinion/30498. Accessed 24 March 2008

Left: The model garden offers five solutions for a domestic garden to help counter the effects of climate change (Photo: Winterbourne Botanic Garden)

Résumé

Au printemps 2006 defra (Department of environment, food and rural affairs, UK) a attribué la somme de 10 000 £ au Jardin botanique de Winterbourne, dans le cadre de son projet 'Climate Challenge'. L'argent a été alloué aux programmes de sensibilisation et d'information du public quant au changement climatique.

Le projet 'Working with the Weather' était tout d'abord destiné au public adulte à qui il était demandé de faire le lien entre les changements dans leur propre jardin et le changement climatique.

Une maquette de jardin a été conçue pour montrer quels éléments pouvaient être intégrés à un espace domestique en vue de parer aux effets du changement climatique. Une brochure présentant ces notions a été réalisée afin d'aider le public à apporter des changements dans leurs propres jardins.

Resumen

En la primavera del 2006 el Jardín Botánico de Winterbourne recibió £10,000 de DEFRA (el departamento de medio ambiente, alimento y asuntos rurales del Reino Unido) como parte de su proyecto del *Reto al Clima*, fondos con el propósito de ayudar a los proyectos que aumentan el conocimiento público sobre el cambio climático.

El proyecto de jardinería climática estaba dirigido a los visitantes adultos a quienes se les pedía relacionaran los cambios en sus propios jardines con el cambio climático. Se diseñó un jardín modelo para demostrar cuales son las características que se pueden incorporar en una situación doméstica para contrarrestar los efectos del cambio climático. Se produjo una hojilla para ayudar a los visitantes a hacer cambios en sus propios jardines.

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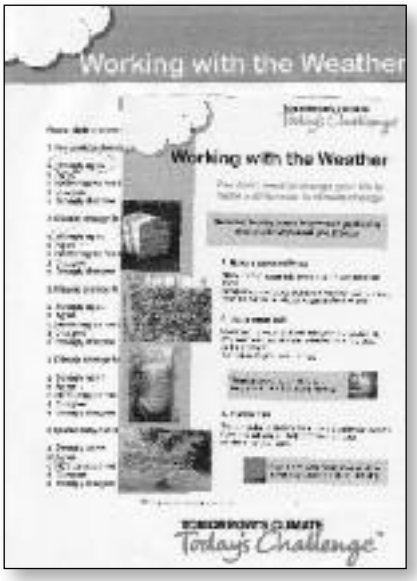


Left: Phase 1 panels used in the model garden to raise awareness about the need to conserve water (Photo: Winterbourne Botanic Garden)

The Green Belt Movement (GBM)

Climate change

a community centred approach

Summary It is estimated that deforestation causes 24% of all CO_2 emissions, contributing more to global emissions than the transport sector. Planting trees is a cost-effective way to redress this imbalance, and the Green Belt Movement (GBM) recognises the potential of the carbon market to meet this challenge. Climate change is not just a challenge for environmentalists and botanists; it highlights the linkage between environment and poverty, and the urgency of addressing these issues together. For 30 years GBM has taken a holistic and grass roots approach to tackling the underlying causes of poverty and environmental degradation. This internationally recognised model for development is now used in carbon offsetting projects. Today, forest cover in Kenya represents only 2% of total land cover. By planting 5 billion trees over the next 50 years forest cover could return to 10%. This article describes how GBM projects focusing on indigenous tree species restore and protect Kenya's standing forests, while simultaneously improving livelihoods.

Introduction

GBM was founded in Kenya over 30 years ago by Wangari Maathai in response to group discussions she held with rural women leading up to the first international UN conference on women. It emerged that they were struggling to provide for their families' basic needs, such as clean drinking water, fuel wood, a sustainable income, and a healthy environment. This echoed what Wangari Maathai has seen on field trips into rural areas in Kenya as a university researcher. The root of these problems lay in environmental degradation, namely deforestation and soil erosion. GBM was created to address the serious problems with a simple solution: working with communities to plant trees.

GBM's philosophy and approach are based on the premise that sustainable development can only take place through recognising the link between the environment, democracy and peace. As a result of our programmes, 40 million trees have been planted, hundreds of thousands of women in rural Kenya have lifted themselves out of poverty, soil erosion has been reduced in critical watersheds, and thousands of acres of biologically rich forests have been restored or protected. It was in recognition of this holistic approach to sustainable development that, in 2004, Wangari Maathai became the first environmentalist and African woman to win a Nobel Peace Prize.

Climate change: a pressing issue for Africa

Climate change threatens the basic elements of life - access to water, food production and health care (Stern, 2006). However, global impacts are unjust in their distribution. While the carbon emissions of countries in the South tend be negligible, because of their limited economic resources and adaptive capacity, they are hit the hardest. It is time developed economies recognise their responsibility and moral obligation, and assist poorer countries to reduce their vulnerability.

According to the Intergovernmental Panel on Climate Change (IPCC), in parts of Africa temperatures have risen twice as fast as in the rest of the world. Africa's poor and vulnerable will be particularly at risk; the effects are already visible in Kenya where droughts have increased fourfold in the past twenty years (Christian Aid, 2006). Health implications are a major

concern, as shifting rainfall patterns are expected to introduce malaria into the Kenyan highlands which, until 20 years ago, was malaria free (Chen, *et al*., 2006). For Kenya, and much of the global South, addressing climate change is not a luxury; it is an issue of life and death.

Protection and restoration of forests

Greenhouse gas emissions from deforestation are estimated to represent more than 18% of current global emissions (see figure 1). Tropical deforestation has a particularly strong effect because tropical forests typically hold around 50% more carbon per hectare than other forests (Houghton, 2005). Today, forest cover in Kenya represents only 2% total land cover, a significant decrease since the 30% cover at the beginning of 20th Century; and far below the UN recommended goal of 10% for sustainable development.

Action to protect the remaining areas of natural forest is clearly an issue of urgency and, as GBM proves, one does not need much money or expertise to plant trees; only community mobilisation to plant and nurture them.

The opportunities of carbon offsetting

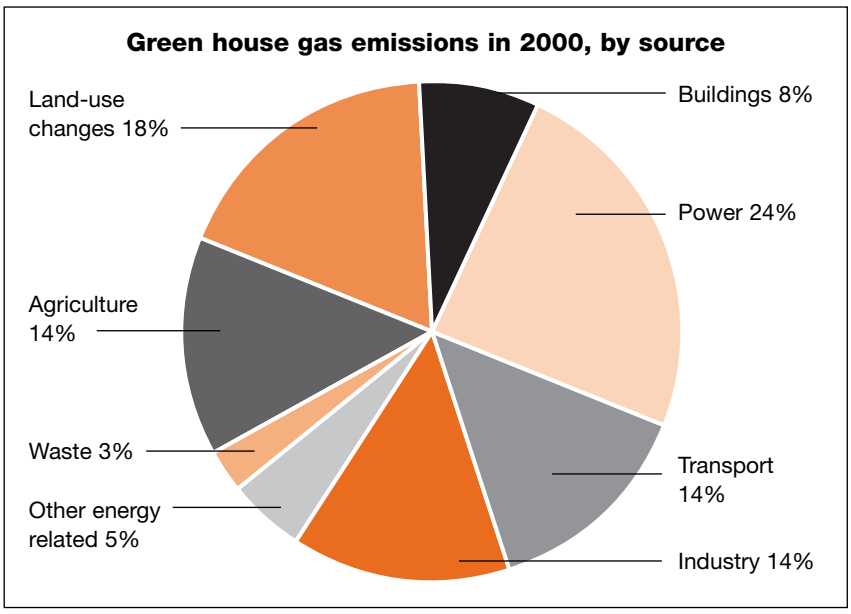
Carbon offsetting means calculating everyday emissions and then paying someone to reduce the carbon dioxide by an equivalent amount. Investment in carbon markets at present takes place mainly through two mechanisms

1. The Clean Development Mechanism (CDM) - governed by the Kyoto Protocol.
2. The voluntary market – separate from the Kyoto Protocol; it refers to voluntary acts by individuals or companies.

This simple principle however has been the subject of controversy. There are concerns that offsetting is a way to ease the polluter's conscience, providing an excuse to continue energy consumption as usual. Furthermore, problems exist over the permanence of carbon sequestered, as there is no guarantee of tree survival. GBM shares many of these concerns and aims to meet them by working only with partners committed to making long term behavioural changes in carbon consumption, and by planting trees in areas that will create self-sustaining forestry systems.

Left: GBM tree planting activities offer communities an alternative livelihood to deforestation (Photo: Green Belt Movement)

The carbon offsetting market presents a first attempt, in global monetary terms, to recognise the value of environmental resources in the form of carbon. From an African perspective, being part of a global attempt to address climate change is an issue of global justice and equity; especially as Africa will be adversely affected. The volume of private finance flowing through the voluntary market has increased significantly, with an eight-fold rise between 2004 and 2005 alone, the majority of which is invested in forestry programmes (Brown *et al*., 2006). GBM shares many of these concerns and aims to meet them by working only with partners who are already working on reducing their carbon emissions and acknowledge tree planting as a way to offset what is 'over and above' their commitments. Many of these partners are also committed to making long term behavioural changes in carbon consumption, and opt for tree planting in areas which will create self-sustaining forestry systems.



Left: Figure 1. Adapted from Stern Review, 2006.

Lessons learned

The problems that GBM addresses are not unique to Kenya; they can be found in communities around the globe, especially in those with degraded lands. GBM has created what we believe to be an African solution to a global problem. This section aims to share the key ideas behind our approach.

Addressing poverty
Broadly speaking, GBM takes a holistic approach to climate change for the following reason: the challenge is not just scientific in nature, it is far more complicated. The intrinsic link between poverty and environmental degradation creates a vicious cycle whereby one causes the other. For example, communities lacking income sources are forced to cut down forests to sell timber. Yet continued deforestation depletes their income sources and exacerbates poverty. Environmental conservation goes hand-in-hand with poverty alleviation. GBM tree planting activities offer communities an alternative livelihood to deforestation, therefore breaking the vicious cycle and addressing climate change in the long term.

Our projects follow a tested ten-step approach, beginning with the voluntary organisation of communities into networks (usually women), and culminating in compensation of seedlings by GBM after verification of survival. The income generated supports these communities and the restored forests offer better access to basic resources such as food and building materials.

GBM's holistic approach to sustainable development recognises that equitable distribution and good governance of resources are one of the foundations for peace. As Wangari Maathai explained during her Nobel Peace Prize Speech, '*A degraded environment leads to a scramble for scarce resources and may culminate in poverty and even conflict*' (2004). In 1992 GBM responded by establishing civic education and advocacy projects. So far 10,000 local people have attended seminars under the initiative and, after recognising this link, have started to participate in the political process and demand better governance.

Community involvement
To address deforestation it is necessary to understand why it is happening. Looking to local communities for the answers ensures the appropriateness and, ultimately, success of a project. Yet too often development projects are based on assumptions made on local people's behalf, failing to address community felt needs. In contrast, GBM projects and policies are shaped and led by local communities from the planning to the implementation phases. Our use of indigenous plant species to preserve biological diversity, depending on the purpose, is testament to GBM's commitment to local approaches with a view to a long-term solution.

Right: Women of the Green Belt Movement network engaging in tree planting activities (Photo: Green Belt Movement)

Self-sustainability
The ultimate goal is for reforestation to become an intrinsic part of Kenyan society, and so far progress is encouraging. With the acquired knowledge of tree planting and the incentives associated with livelihood improvement, members continue to protect their forests to meet their own needs. The product is a self-sustaining forestry system which does not depend on continued outside support for survival.

The future of carbon offsetting at GBM
The urgency of climate change is conclusive, and carbon sequestration through forestry projects offers a potential mechanism for reducing emissions. GBM believes there is an opportunity to create a fair-trade carbon market which mobilises and empowers communities to improve their livelihoods using tree planting as an entry point while at the same time creating carbon sinks. Our long term vision is to plant 5 billion trees in Kenya over the next 50 years; returning forest cover to 10%. With our experience and growing profile, GBM is well-positioned to engage greater numbers of people with our development model at grassroots levels in Africa and beyond.

References

- Brown, D., Luttrell, C. and Peskett, L, 2006, Making voluntary carbon markets work better for the poor: the case of forestry offsets. *Overseas Development Institute Forestry Briefing 11* . Online, available at: http://www.odi.org.uk/fpeg/publications/policybriefs/forestrybriefings/ODI%20Forestry%20Briefing%2011.pdf. Accessed 8th January
- Christian Aid, 2006, *Life on the Edge of climate Change: the plight of pastoralists in Northern Kenya*. Online, available at: http://www.christianaid.org.uk/stoppoverty/climatechange/facts/index.aspx. Accessed 10th January 2008
- Chen, H., Githeko, A.K., Zhou, G.F., Githure, J.I. and Yan, G.Y., 2006, New records of *Anopheles arabiensis* breeding on the Mount Kenya highlands indicate indigenous malaria transmission. *Malaria Journal*, 5 (17)
- Houghton, R.A., 2005, Tropical deforestation as a source of greenhouse gas emissions, in: Mautinho, P. and Schwartzman, S. (eds). *Tropical Deforestation and Climate Change*. Instituto de Pesquisa Ambiental da Amazonia and Environmental Defense, Belem. Brazil. Online, available at: http://www.environmentaldefense.org/documents/4930_TropicalDeforestation_and_ClimateChange.pdf Accessed 10th January 2008
- Maathai, W. (2004). Nobel Peace Prize Acceptance Speech. Online, available at: http://greenbelt movement.org/a.php?id=34. Accessed 15th February 2008
- Intergovernmental Panel on Climate Change, 2000, *Land use, land use change and forestry. A special report*. Cambridge, UK, Cambridge University Press
- Stern, N., 2006, The Stern Review: *The Economics of Climate Change*. Online, available at: http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_r eview_report.cfm. Accessed 15th January 2008

Résumé

Il est estimé que la déforestation cause 24% de toutes les émissions de CO_2, soit plus que la contribution du secteur du transport à l'émission globale. La plantation d'arbres est un moyen rentable de redresser le déséquilibre, et le Green Belt Movement (GBM) reconnaît le potentiel offert par le marché du carbone pour faire face à ce défi. Le changement climatique n'est pas seulement un défi pour les environnementalistes et les botanistes, il souligne le lien entre environnement et pauvreté, et l'urgence de s'attaquer à ces problèmes sans les dissocier. Depuis 30 ans le GBM a choisi une approche holistique et locale pour enrayer les causes sous-jacentes de la pauvreté et de la dégradation de l'environnement. Ce modèle en faveur du développement, reconnu internationalement, est maintenant utilisé dans les projets de compensation carbone. Actuellement, la forêt au Kenya représente seulement 2% de la couverture totale du pays. En plantant 5 milliards d'arbres dans les 50 prochaines années, la couverture forestière pourrait retrouver son taux de 10%. Cet article décrit comment les projets du GBM, ciblés sur des espèces indigènes d'arbres, restaurent et protègent les forêts en place au Kenya tout en améliorant simultanément les moyens d'existence de la population.

Resumen

Se estima que la deforestación causa el 24% de todas las emisiones de CO_2, contribuyendo más a las emisiones globales que el sector transporte. Plantar árboles es una forma efectiva de corregir este desbalance, y el movimiento cinturón verde (GBM) reconoce el potencial del mercado del carbón para alcanzar este reto.

Cambio climático no solamente es para ambientalistas y botánicos, este remarca el enlace entre medio ambiente y pobreza, y la urgencia de dirigir estos temas juntos. Por 30 años GBM ha tomado una visión holistica para atacar las principales causas de pobreza y degradación ambiental. Este modelo internacionalmente reconocido de modelo para el desarrollo es ahora usado en proyectos para disminución de las emisiones de carbono.
Hoy, la cubierta del bosque en Kenia representa únicamente el 2% del bosque total de la cubierta de la tierra. Plantando 5 billones de árboles en los próximos 50 años, la cubierta podría incrementar al 10%. Este artículo describe como los proyectos del GBM se enfocan a las especies de árboles nativas para restaurar y proteger los bosques de Kenia, mientras simultáneamente se mejorar los alrededores.

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Naviguer pour sauver le monde!

Navegando para salvar la tierra

Rowena Ewens

Sailing
to save the world!

Right: Rowena Ewens navigates the River Thames during The Low Carbon Lifestyle Tour (Photo: Rowena Ewens)

Summary The Low Carbon Lifestyle Tour 2007 sailed around Britain in a zero-emission micro yacht promoting low carbon lifestyle. The tour visited over 40 ports including Swansea, Liverpool, Glasgow, Edinburgh, Newcastle, London, Brighton and Southampton. At each port, Mukti Mitchell, a sailor, carpenter and pioneer of low carbon lifestyles, presented talks on how to lead a low carbon lifestyle.

With the increasing public debate about climate change, The Low Carbon Lifestyle Tour was timed perfectly to promote low carbon lifestyles. The Tour included a range of issues from recycling to recreation and house insulation to holidays. So as I stepped aboard 'Chance' the 15ft micro-yacht at Scarborough, I could never have envisaged what crewing for the next few months would involve.

Right: Sailing alongside the White Cliffs of Dover (Photo: Rowena Ewens)

We were literally camping at sea – with one stove, a pressure cooker and a selection of carefully organised storage boxes full of organic goodies that would serve us from port to port. There was also a small solar panel that generated enough energy to power a main battery, which was used to power a few lights, the navigation equipment and even the lap top, albeit occasionally. Resources were limited by storage space and this really put the essence of leading a low carbon lifestyle into practice! From dawn 'til dusk, we were close to nature. This was a wonderful experience full of sunsets and moon lit skies. We sailed with a family of seals and through rows of offshore wind-turbines, we navigated the River Thames and crossed one of the world's busiest shipping channels at Dover.

My mission was to establish the effectiveness of this project in changing people's attitudes and behaviours towards a low carbon lifestyle. This was accomplished by interviewing attendees about their current day-to-day behaviour and how, if at all, they planned to make changes towards a low carbon lifestyle. Months later, I contacted them again to identify any changes they had made, any motivating factors that had encouraged them to make these changes and any barriers they had encountered. This research aims to inform those interested in changing people's attitudes and behaviour towards a low carbon lifestyle. For copies of the MSc dissertation entitled 'How effective is The Low Carbon Lifestyle Tour at changing people's attitudes and behaviour towards a low carbon lifestyle', please contact me.

Résumé

Le Low Carbon Lifestyle Tour 2007 a navigué autour de la Grande-Bretagne dans un micro yacht à émissions-zéro, promouvant un style de vie à carbone réduit. Le Tour a visité plus de 40 ports, y inclus Swansea, Liverpool, Glasgow, Edinburgh, Newcastle, London, Brighton et Southampton, où Mukti Mitchell a fait des présentations pour montrer comment mener un style de vie à carbone réduit.

Resumen

El Tour 2007 Estilo Bajo en Carbono navegó alrededor de Gran Bretaña en un micro yate emisión-cero promoviendo un estilo de vida de baja emisión de CO_2. El tour visitó más de 40 puertos incluyendo Swansea, Liverpool, Glasgow, Edinburgh, Newcastle, London, Brighton and Southampton, donde Mukti Mitchell dió conferencias acerca de cómo llevar un estilo de vida con bajo emisión de CO_2.

Rowena Ewens
Email: rowenaewens@hotmail.com

The Low Carbon Lifestyle Tour was sponsored by Resurgence, Co-operative Membership, The Phone Co-op, Ecotricity, Samskara Design, Annery-Kiln web design, The RH Southern Trust, The Ashden Trust and John Pontin Group. In association with The Green Blue.

For additional information visit: www.lowcarbonlifestyle.org

Christine Newton, Susan Allan and Mary Smith

Plants that travel the world

Summary There was a time when we in the UK were largely dependent on local supplies of vegetables and fruits. This meant that in some seasons there was an abundance of produce while in others, particularly in winter, we eked out our limited range of produce (including the many fruits that were harvested in autumn), while longing for the fresh vegetables and fruits that would arrive with spring and summer. Now in the 21st century, the shelves of supermarkets are filled with fresh vegetables and fruit from all over the world regardless of the season. Here we present an activity that can be used to stimulate awareness of issues related to sustainability and the environmental costs of bringing fresh food to our supermarkets. There are plenty of cross-curricular themes that can be developed. The questions and ideas offered can be used as a framework and can be adapted for a particular class or groups of students. It would be useful to have a world map - laminated if possible – for students to draw lines on. Alternatively an image of a world map can be projected onto paper on the wall.

Food miles activity

Aim of activity:
To help students understand where their food comes from and that there are environmental costs associated with bringing fresh food to our supermarkets

Age range: 8 – 12

Time needed: 40 minutes

Group size:
whole class and small groups

Setting: Classroom

Key vocabulary:
Food Miles, Environmental Costs

Preparation

- Display a selection of foods for students to examine
- Prepare a table (see below) for each student or group of students
- Provide a laminated world map or use an overhead projector or computer to project one onto paper. Photocopied sheets could also be used

Procedure

- Show the class the display. Some foods like apples, melons or mangoes, have stickers on them saying which country they have come from. Ask the students to see if they can work out how far this food has travelled before it was bought.
- Ask the students to select three foods and complete the table.
- Ask students to write the names of the food in the first column and the country where they originated from in the second column. Then ask the students to find out approximately how far this country is from the UK and write this in the third column.
- Explain to the students that when we transport food across the world, we use up lots of fuel and create pollution, which damages the environment. Explain that we can get a rough idea of the damage caused to the environment by awarding 1 ‘damage point’ for each 100 km travelled. Students can then work out their ‘damage points’ for each food and write this in the fourth column.
- Ask the students to find the countries on a map of the world and draw a line to link the countries with the UK.

Name of food	Country of origin	Distance travelled in km	“Damage points” (100 km = 1 point)

- In groups, ask students to think and talk about the following questions.
  - Do we need to buy food from countries that are so far away or can we buy locally?
  - Do we really want to eat strawberries in the winter?
  - Chocolate and bananas will not grow in the UK. Think about how you could help the growers by choosing 'ethically traded' products.
  - How many forms of transport are used to bring foods to the UK?

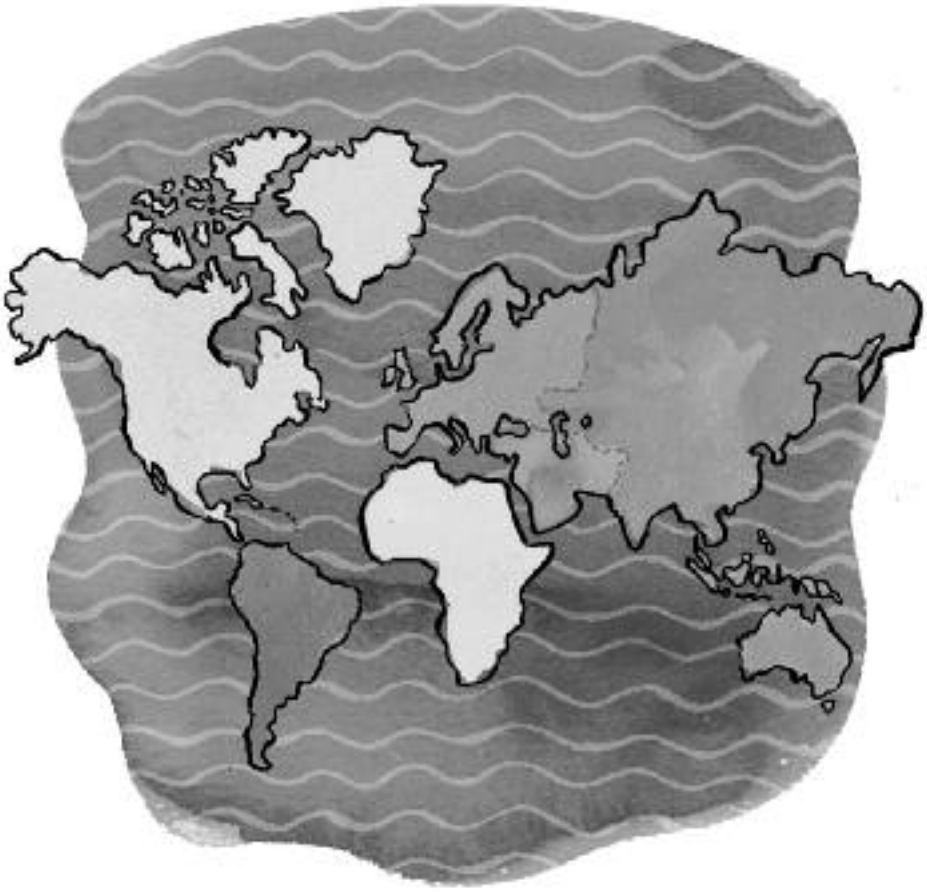
Extension

- Ask students to use this information to help produce a poster or to prepare an assembly to make other people think about where their food comes from.
- Ask students to explore the different ways in which food is transported. Are there modes of transport that are less environmentally damaging than others? Ask students to prepare a leaflet about this.

Evaluation

Ask pupils to complete the following sentences:

- From doing this activity, I learned ...
- I was surprised that ...
- I would like to know more about ...



Résumé

Il fut un temps où, au Royaume Uni, nous étions largement dépendants des provisions locales de fruits et de légumes. Cela signifiait qu'à certaines saisons, il y avait une abondance de produits et qu'à d'autres, particulièrement en hiver, nous vivions sur nos ressources peu diversifiés et attendions avec impatience les fruits et légumes frais qui n'arrivaient qu'avec le printemps et l'été, ainsi que de nombreux fruits qui étaient récoltés à l'automne. Maintenant, au 21ème siècle, les rayons des supermarchés sont remplis de légumes et de fruits frais presque en toutes saisons et qui proviennent du monde entier.

Nous présentons ici une activité destinée à sensibiliser aux problèmes liés au développement durable et aux coûts environnementaux induits par l'acheminement de produits frais dans nos supermarchés. De nombreux thèmes transversaux peuvent être développés. Les questions et les idées proposées peuvent servir de trame et être adaptées à une classe d'un niveau particulier ou des groupes d'étudiants. Pour mener cette activité, il sera utile d'avoir une carte du monde, si possible plastifiée, pour que les étudiants puissent dessiner des lignes dessus ou bien de projeter une mappemonde sur du papier au mur.

Resumen

Hubo un tiempo cuando el Reino Unido fue grandemente dependiente de la producción local de frutos y vegetales. Esto significa que en algunas estaciones hubo una abundancia de productos y en otras, principalmente en invierno, había un rango de producción limitada, que terminaba con el incremento en la producción de los vegetales y frutos que llegaban en la primavera y verano – y los variados frutos que cosechados en otoño. Ahora en el siglo 21, los anaqueles de los supermercados están llenos con vegetales y frutos frescos independientemente de la estación provenientes de todas las partes del mundo.

Aquí, nosotros presentamos una actividad que puede ser usada para estimular la conciencia de los temas relacionados con la sustentabilidad y de los costos ambientales de traer comida fresca a nuestros supermercados. Hay suficientes temas a través de la currícula que pueden ser desarrollados. Las preguntas e ideas ofrecidas pueden ser usadas como estructura y pueden ser adaptadas por una clase particular o grupo de estudiantes. Podría ser útil tener un mapa mundial –laminado si es posible. Para que los estudiantes dibujen unas líneas sobre ello. Alternativamente, una imagen de un mapa mundial puede ser proyectado sobre papel en la pared.

Adapted from an activity produced by RBG, Kew at Wakehurst Place and published on the Science and Plants in Schools (SAPS) website.

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Science and Plants in Schools
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Resources

Resources

For more resources on communicating climate change, have a look on the BGCI website at www.bgci.org/education/climate_change_communication/

Books

BGCI Climate change report

This report is designed to fill the gap in current literature on how plants, the fundamental members of the majority of Earth's ecosystems, are being affected by climate change. It gathers and summarises in one place the most up-to-date scientific thinking on the effects of the various aspects of climate change on plants the world over. The report looks at the physiological effects of climate change on plants, including plant responses to rising CO_2, temperature change, water supply and soil composition, as well as detailing how plant-to-plant, plant-pathogen and plant-pollinator relationships may change and thus impact plant community structure, ecosystems and the livelihoods of many millions of people. Use of existing red lists allows the document to outline what types of species are particularly at risk and what can be done to mitigate the negative effects of climate change. The report also ties the science in with the *Gran Canaria Declaration on Climate Change and*

Disponible

Plus d'outils pour communiquer sur le changement climatique : allez sur le site Internet du BGCI: www.bgci.org/education/climate_change_communication/

Livres

Rapport du BGCI sur le changement climatique

Ce rapport entend combler le vide existant dans la littérature actuelle concernant la façon dont les végétaux, éléments essentiels de la plupart des écosystèmes terrestres, sont touchés par le changement climatique.
Il rassemble et résume les dernières découvertes scientifiques sur les différents effets du changement climatique sur les plantes du monde entier. Le rapport étudie les effets physiologiques du changement climatique sur les végétaux, notamment leurs réactions à l'augmentation du CO_2 et aux modifications de la température, des ressources en eau et de la composition du sol. Il décrit aussi comment les relations entre les végétaux, et entre ceux-ci et les agents pathogènes, ainsi que les pollinisateurs, peuvent évoluer et influer sur la structure des communautés végétales, les écosystèmes et la vie de millions de personnes. L'utilisation des listes rouges actuelles permet de mettre en

Recursos

Para información adicional en el tema comunicando el cambio climático, favor de consultar el sitio web de la BGCI www.bgci.org/education/climate_change_communication/

Libros

Reporte del cambio climático de la BGCI

Este reporte esta diseñado para llenar el espacio existente en la literatura de como las plantas, organismos fundamentales en la mayoría de ecosistemas terrestres están siendo afectadas por el cambio climático.
Es un resumen actualizado del pensamiento científico y hechos del cambio climático que las afecta alrededor del mundo. En el se tratan los efectos fisiológicos, incluyendo incremento de CO_2, cambio de temperatura, disponibilidad de agua y composición del suelo. Asimismo incluye el posible cambio en las interacciones planta-planta, planta-patógeno y plantas-polinizador sus consecuencias y el impacto en la estructura de las comunidades, ecosistemas y el sustento de millones de gentes. El uso de la lista roja permitió a este documento seleccionar el tipo y las especies que se encuentran en riesgo; también explica qué se puede hacer para mitigar los

Plant Conservation (on the BGCI website at www.bgci.org/conservation /climatechange/) and goes on to outline the management responses available to us and make recommendations for further action. The report is being sent out to all BGCI members.

Climate Change ~ local and global: an enquiry approach

A new resource from the excellent TIDE (Teachers in Development Education) group. These materials adopt a learner-centred, enquiry approach, to climate change, including ideas for planning and teaching, supported by full colour photos and illustrations, internet links and downloadable material. Issues covered include 'Why take an enquiry approach to teaching about climate change?', 'Sustainable development and climate change', 'Planning an enquiry on climate change' and 'Supporting enquiry learning'.

Teachers in Development Education (TIDE)
ISBN-10: 0 948838 92 2
ISBN-13: 978-0-948838-92-7
Tide – Centre, G04 Millennium Point, Curzon Street, Birmingham B4 7XG, UK.
www.tidec.org/Resources/

Social learning towards a sustainable world: Principles, perspectives, and praxis

This comprehensive volume - containing 27 chapters and contributions from six continents - presents and discusses key principles, perspectives, and practices of social learning in the context of sustainability. Social learning is explored from a range of fields challenged by sustainability

évidence les espèces en danger et d'identifier ce qui peut être fait pour atténuer les effets néfastes du changement climatique. Le rapport intègre une dimension scientifique en se référant à la *Déclaration de la Grande Canarie sur le changement climatique et la conservation des végétaux* (sur le site du BGCI : www.bgci.org/conservation/climatecha nge/), il présente les solutions dont nous disposons en matière de gestion et fait des recommandations concernant des mesures à prendre à l'avenir.

Le rapport est envoyé à tous les membres du BGCI et peut être téléchargé à partir du site du BGCI

Changement climatique - local et mondial : une approche fondée sur l'enquête

Un nouvel outil du groupe TIDE (Teachers in Development Education: Enseignants dans l'éducation au développement). Ces matériaux didactiques abordent le changement climatique selon une méthode centrée sur l'apprenant et reposant sur des enquêtes. Ils contiennent des idées pour programmer et enseigner, accompagnées de photos et d'illustrations en couleurs, de liens Internet et d'outils à télécharger. Parmi les sujets étudiés : « Pourquoi choisir la technique de l'enquête pour l'enseignement relatif au changement climatique ? », « Développement durable et changement climatique », « Planifier une enquête sur le changement climatique », « En faveur de l'enseignement par enquêtes ».

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www.tidec.org/Resources/

L'apprentissage social dans l'optique d'un monde durable : principes, pratique et perspectives

Cet ouvrage très détaillé - contenant 27 chapitres et des contributions des 6 continents - présente et analyse les principes clés, les perspectives et la pratique de l'apprentissage social dans

efectos negativos del cambio climático. El documento vincula científicamente con "*Gran Canaria Declaration on Climate Change and Plant Conservation* (www.bgci.org/conservation/climate change/) en el manejo, respuestas y recomendaciones de acciones para llevar a cabo.

Cambio climático ~ local y global: plantear una propuesta

Es una fuente nueva del grupo TIDE (Teachers in Development Education): con enfoque educativo, plantear una propuesta para el cambio climático, contiene los materiales con ideas a planear y educar. Los temas están ilustrados con imágenes, fotografías y ligas en Internet; todo esto se puede descargar electrónicamente. Los títulos incluyen ' El porqué plantear una propuesta para educar en el cambio climático', 'Desarrollo sustentable y el cambio climático' 'Planeamiento e interrogaciones en el cambio climático' además de 'Apoyo a las interrogativas del aprendizaje'.

Profesores en el desarrollo de la educación : Teachers in Development Education (TIDE)
ISBN-10: 0 948838 92 2
ISBN-13: 978-0-948838-92-7
Tide – Centre, G04 Millennium Point, Curzon Street, Birmingham B4 7XG, UK.
www.tidec.org/Resources/

Aprendizaje social hacia un mundo sustentable: principios, perspectivas y actividades prácticas (praxis)

Este volumen contiene 27 capítulos y contribuciones de 6 seis continentes. En ellos se presenta y discuten puntos clave, perspectivas, prácticas de aprendizaje social en el contexto sustentable. El tema aborda varios retos: organización, educación y psicología del aprendizaje; también se tocan los temas de consumismo y educación critica al mismo. Una sección completa del libro contiene casos de estudio que reflejan este tema; organizaciones y comunidades que usan las formas sociales en vía de la sustentabilidad.

Arjen E.J. Wals (editor), 2007, 540 pp, hardback
ISBN: 978-90-8686-031-9
www.wageningenacademic.com/social learning/

including: organisational learning, education, learning and educational psychology; and consumerism and critical consumer education. An entire section of the book is devoted to a number of reflective case studies of people, organisations and communities using forms of social learning in moving towards sustainability.

Arjen E.J. Wals (editor), 2007, 540 pp, hardback
ISBN: 978-90-8686-031-9
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BGCI medicinal plants report

BGCI has published the findings of a year-long investigation into the state of medicinal plants around the world in a new report. Outlining the main trade, livelihood and conservation issues surrounding medicinal plants, the report also illustrates the many ways in which botanic gardens can and do contribute to protecting the plants that heal us. Key to this is the expansion of the role of botanic gardens; from traditional *ex situ* conservation to increasing involvement with community work and partnering with other bodies to contribute towards successful *in situ* medicinal plant conservation work. The report, entitled 'Plants for life: Medicinal plant conservation and botanic gardens', draws together the inspirational involvement of botanic gardens in medicinal plant conservation and recommends focus areas and species for future work.

le contexte du développement durable. L'apprentissage social est étudié à travers différents domaines visés par le développement durable, notamment: l'apprentissage organisationnel, l'éducation, la psychologie de l'éducation et de l'apprentissage, la sensibilisation et l'éducation critique du consommateur. Toute une partie du livre est consacrée à des études de cas (particuliers, organisations ou communautés) montrant comment diverses formes d'apprentissage social peuvent être mises à profit dans l'optique du développement durable.

Arjen E.J. Wals (dir. publ.), 2007, 540 p, édition cartonnée
ISBN: 978-90-8686-031-9
www.wageningenacademic.com/social learning/

Rapport du BGCI sur les plantes médicinales

Dans un nouveau rapport, le BGCI publie les résultats d'une enquête d'une durée d'un an sur les plantes médicinales dans le monde. Présentant les principaux aspects liés au commerce, aux moyens de subsistance et à la conservation des plantes, le rapport montre également les divers moyens par lesquels les jardins botaniques peuvent contribuer - et contribuent effectivement - à protéger ces plantes qui nous soignent. Cela tient essentiellement à l'élargissement de leur rôle, de la protection classique ex situ vers une participation accrue dans le travail des communautés, en partenariat avec d'autres organisations, pour protéger les plantes médicinales in situ. Le rapport, intitulé « Plants for life: Medicinal plant conservation and botanic gardens » (Des plantes pour la vie : la protection des plantes médicinales et les jardins botaniques), montre comment les jardins botaniques sont une source d'inspiration en matière de conservation des plantes médicinales et fait des recommandations sur les espèces et les domaines d'intervention à privilégier à l'avenir.

Belinda Hawkins, 2008, Botanic Gardens Conservation International.
ISBN: 1-905164-21-1
A télécharger ou commander gratuitement sur www.bgci.org/medicinal/medplants/

Reporte de plantas medicinales de la BGCI

Como resultado de una larga investigación a nivel mundial la BGCI publicó un libro del estado de conocimiento actual de las plantas medicinales; enfocado al comercio, sustento y conservación en torno a éstas; en el se ilustran numerosas maneras en las cuales los jardines botánicos pueden contribuir en la protección de las plantas que curan. Aquí se expone el papel fundamental que los jardines botánicos desempeñan, desde la conservación las plantas medicinales ex situ hasta el involucrar a las comunidades para trabajar en conjunto con otras asociaciones en vías de una conservación efectiva in situ. El titulo de 'Plantas para la vida: Plantas Medicinales Conservación y Jardines Botánicos' acerca y conjunta la inspiración de los jardines botánicos conservación y recomendaciones en áreas de futuro trabajo con las plantas medicinales

Belinda Hawkins, 2008, Botanic Gardens Conservation International.
ISBN: 1-905164-21-1
Para obtener una versión impresa o electrónica gratis de este trabajo, por favor consultar el sitio web: www.bgci.org/medicinal/medplants/

Recursos electrónicos

Controversias en el cambio climático: una guía simple
www.royalsoc.ac.uk/climateguide

La Royal Society, del Reino Unido ha elaborado una perspectiva general y actualizada del entendimiento científico del cambio climático; este tiene como objetivo dar a los no expertos un mejor

Belinda Hawkins, 2008, Botanic Gardens Conservation International.
ISBN: 1-905164-21-1
Download or order for free from www.bgci.org/medicinal/medplants/

Web resources

Climate change controversies: A Simple Guide
www.royalsoc.ac.uk/climateguide

The Royal Society, UK, has produced an overview of the current state of scientific understanding of climate change to help non-experts better understand some of the debates in this complex area of science. It identifies and responds to eight common arguments and sets out where the weight of scientific evidence lies. Examples of the misleading arguments they respond to include 'The Earth's climate is always changing and this is nothing to do with humans' and 'Carbon dioxide only makes up a small part of the atmosphere and so cannot be responsible for global warming'.

Designed for use by the general public, educators will find it an invaluable source of information to help answer questions, for background reading and for preparing activities on climate change.

Climate change college
www.climatechangecollege.org/home.php

Part of a scheme funded by Ben and Jerry's ice cream manufacturers to support and develop advocates for climate change campaigning. The group's main initiative is to send eight young people to the Arctic each year and train them in business management to develop their own ideas on counteracting climate change. In addition, they have an on-line learning area, free to use, with six modules (they estimate each takes an hour to work through) on communicating climate change, carbon footprint, climate change and economics, fair-trade, science of climate change technology solutions and polar regions.

Each module contains a useful range of case studies, guidelines and research, illustrated with excellent

Outils Internet

Controverses sur le changement climatique : un guide simple
www.royalsoc.ac.uk/climateguide

La Société Royale de Grande-Bretagne a produit un aperçu de l'état actuel des connaissances scientifiques sur le changement climatique pour aider les non-spécialistes à mieux comprendre certains débats dans un domaine scientifique complexe. Il identifie et répond à huit questions courantes et montre où sont les preuves scientifiques. Parmi les arguments fallacieux traités : « le climat change depuis toujours et cela n'a rien à voir avec les activités humaines » ; ou « le CO_2 ne représente qu'une faible proportion de l'atmosphère et ne peut donc pas être responsable du réchauffement climatique. » Conçu pour être utilisé par tout un chacun, ce guide constitue pour les éducateurs une source très utile d'informations pour répondre aux questions, trouver des références ou préparer des activités se rapportant au changement climatique.

Le collège du changement climatique
www.climatechangecollege.org/home.php

Il s'agit d'une partie d'un projet financé par le fabricant de glaces Ben and Jerry's pour soutenir et former des militants qui pourront faire campagne sur le changement climatique. La principale initiative du groupe consiste à envoyer chaque année huit jeunes dans l'Arctique et à les former à la gestion d'entreprise pour qu'ils conçoivent eux-mêmes des moyens de lutter contre le changement climatique. Ils disposent en outre d'un lieu d'apprentissage virtuel, libre d'utilisation, comportant 6 modules (chacun prenant environ 1 heure) : communication sur le changement climatique, l'empreinte carbone, le changement climatique et l'économie, le commerce équitable, aspects scientifiques des solutions technologiques et les régions polaires. Chaque module présente une série d'études de cas, des lignes directrices et des travaux de recherche illustrés par des graphiques et des images, ainsi que des outils à télécharger, des

entendimiento sobre los debates de esta compleja área de la ciencia. El documento identifica y responde a ocho de los temas más comunes en los que existe la mayor evidencia científica. Ejemplifica algunas de las respuestas a discusiones mal interpretadas incluyendo: 'el clima de la tierra está constantemente cambiando y la humanidad no es responsable de ello' como 'la producción del dióxido de carbono es sólo una pequeña parte de la atmósfera y ésta no es responsable del sobrecalentamiento del planeta'. El reporte está diseñado para el público en general y a los educadores quienes encontraran información y repuestas a numerosas preguntas con referencias bibliográficas para preparar sus actividades relacionadas al cambio climático.

Colegio del cambio climático
www.climatechangecollege.org/home.php

Parte del proyecto, fundado por la compañía de los 'Ben and Jerry', desarrolla la iniciativa principal de cada año enviar a ocho jóvenes al Ártico, allí entrenarlos en el manejo de negocios para que con sus propias ideas desarrollen estrategias para combatir el cambio climático. Se les proporciona en línea electrónica, una área de aprendizaje con seis módulos de acceso libre (estimando que cada modulo toma aproximadamente una hora de trabajo) en torno a comunicación del cambio climático, huella de carbono, política económica en el cambio climático, comercio-ético (comercio justo), ciencia del cambio climático soluciones y tecnologías en regiones polares.

Cada modulo contiene ejemplos de casos estudiados, pautas e investigaciones; ilustraciones con diagramas, imágenes; ligas electrónicas de donde descargar archivos de la Internet y al final un cuestionario. De manera amena y fácil para consultar y entender los cambios climáticos; los módulos también incluyen aspectos útiles para estudiantes de mayor edad y publico en general.

diagrams and images throughout, plus resource downloads and weblinks, with a quiz at the end. A quick, interesting and fun way of brushing up on your climate change understanding, the modules also include content that would be useful to use with older students and the general public.

David Suzuki Foundation:
www.davidsuzuki.org/Climate_Change/

This site offers an excellent introduction to climate change and regular updates of the latest news and reports on the topic. It contains sections covering the science of climate change, impacts, causes, solutions and ideas for action, plus resources. The impacts section is wide ranging, from imperilled ecosystems to economic impacts.

Cambio climático en México
http://cambio_climatico.ine.gob.mx/ (en español),
http://cambio_climatico.ine.gob.mx/index2.html (In English)

This website has been developed by Mexico's National Institute of Ecology to offer public access to information on climate change and its effects. Relevant information on activities and programmes developed in Mexico is presented.

The site also includes a section (in Spanish) on Frequently Asked Questions with answers to questions such as 'What is climate change?', 'Where and why are we vulnerable?', and 'What is being done to mitigate it?.

BGCI is grateful to Laurel McIvor, Curator of Interpretation at Nova Scotia Museum of Natural History, Canada, and Orlik Gomez Garcia, Head of Education, Jardín Botánico Francisco Javier Clavijero, Mexico for their contribution to the resource section.

liens vers d'autres sites et un bref questionnaire. Une façon rapide, intéressante et ludique de mettre à jour ses connaissances sur le changement climatique. Les modules comprennent également des éléments qui pourraient être utiles à des étudiants plus âgés ou un public plus large.

Fondation David Suzuki :
www.davidsuzuki.org/Climate_Change/

Ce site offre une très bonne introduction au changement climatique avec des mises à jour régulières sur les informations et rapports les plus récents sur le sujet. Il comporte différentes rubriques : aspects scientifiques du changement climatique, effets, causes, solutions et idées envisageables, ressources. La rubrique consacrée aux effets couvre un large éventail de sujets, depuis les écosystèmes en danger jusqu'aux effets économiques. Ce site est à la fois utile aux éducateurs qui souhaitent mettre à jour leurs connaissances sur le changement climatique et commode à utiliser avec les groupes d'élèves les plus âgés.

Cambio climático en México
http://cambio_climatico.ine.gob.mx/ (en espagnol),
http://cambio_climatico.ine.gob.mx/index2.html (en anglais)

Ce site a été réalisé par l'Institut national d'écologie du Mexique pour fournir au public des informations sur le changement climatique et ses effets. Il présente des renseignements sur les activités et projets mis au point au Mexique. Le site comprend également une partie (en espagnol) sur les questions les plus fréquentes et les réponses correspondantes : « Qu'est-ce que le changement climatique ? », « En quoi et pourquoi sommes-nous vulnérables? », « Qu'a-t-on entrepris pour en atténuer les effets ? »,« Que pouvons-nous faire contre ces changements? ».

Le BGCI remercie Laurel McIvor, Conservateur chargé de l' interprétation au Muséum d'histoire naturelle de Nouvelle-Ecosse (Canada) et Orlik Gomez Garcia, Responsable de l'éducation, Jardín Botánico Francisco Javier Clavijero (Mexique) pour leurs contributions à la section ressources.

Fundación David Suzuki:
www.davidsuzuki.org/Climate_Change/

Este sitio web da una introducción excelente al cambio climático y es constantemente actualizado. En el se proporcionan datos científicos del impacto, causas, soluciones y puntos de acción, entre otros. La sección de impacto es muy amplia desde organismos en peligro de vida hasta la política económica del impacto. Posee información muy útil para educadores que gustan estar al día en cuando al conocimiento de estos temas, además de presentar buenas herramientas a usar en escuelas con grupos de edad avanzada.

Cambio climático en México
http://cambio_climatico.ine.gob.mx/ (en español),
http://cambio_climatico.ine.gob.mx/index2.html (en ingles)

El Instituto Nacional de Ecología en México produjo un sito web para el uso publico. La meta es concienciar al usuario en el cambio climático y sus efectos. Contiene información relevante y los programas que se están llevando a cabo en México. También se incluye una sección (en español) de las preguntas que se presentan más frecuentemente como son: qué es el cambio climático, donde y por qué somos vulnerables, qué se está haciendo para mitigar este cambio, y lo mas importante, acciones: qué podemos hacer en contra de estos cambios.

BGCI agradece a Laurel McIvor, Curador de Interpretation at Nova Scotia Museum of Natural History, Canada, y a Orlik Gómez García, Jefe de Educación, Jardín Botánico Francisco Javier Clavijero, México por sus contribuciones en la sección de recursos.

Training opportunity with BGCI and RBG Kew: International Diploma in Botanic Garden Education 2008

Right: Participants on the 2006 diploma course came from all over the world

The next International Diploma in Botanic Garden Education is being held in September/October 2008. Organised by BGCI and the Royal Botanic Gardens, Kew, this five week course aims to equip participants with the skills and strategies needed to communicate effectively with their varied audiences. By the end of the course, participants will have an understanding of all the aspects required to create an education master plan for their site.

Above: Field trips are an integral part of the course

The emphasis of the course is on interactive learning and the application of skills to the participants' working context, with lectures, workshops, seminars, practical activities and field visits. Topics covered include interpretation principles and practices, lifelong learning strategies, the history and development of education for sustainable development, an overview of learning in botanic gardens, fundraising, marketing, networking and evaluation.

Right: Success! Robbie Cereno from Makiling Botanic Garden, Philippines, receiving a certificate of attendance from BGCI's Secretary General, Sara Oldfield

Testimonials "This course is a MUST for anybody out there who is conducting environmental education in botanical gardens ….your conservation site will definitely echo out conservation messages clearly and effectively if you know how to get messages out. This course is that tool."

"The entire experience is 'relevant, revealing, provoking' for me personally and professionally. The training programme has fulfilled my requirements beyond my expectations in terms of the content and exposure provided….the key attribute of the programme is interacting with committed, passionate experts from various disciplines, who shared their experience in an enjoyable manner."

"I do not doubt that my attendance on the course has widened my professional profile as well as understanding of concepts and application within the context of environmental education."

Visit the RBG Kew website (www.kew.org/education/bge.html) or the BGCI website (http://www.bgci.org/education/diploma_course_outline) for more information and application details - deadline for submission of applications is 30th June 2008.

How to join Botanic Gardens Conservation International

The mission of BGCI is to mobilise botanic gardens and engage partners in securing plant diversity for the well-being of people and the planet. It was founded in 1987 and now includes over 525 member institutions in 115 countries.

Institutions can join BGCI for the following benefits:

- Membership of the worldwide plant conservation network
- Botanic Garden Management Resource Pack (upon joining)*
- Regular publications:
  - the regular newsletter, *Cuttings*
  - *BGjournal* – an international journal for botanic gardens (2 per year)
  - *Roots* - environmental education review (2 per year)
  - A wide range of new publications
- Invitations to BGCI congresses and discounts on registration fees
- BGCI technical support and advisory services

	Institution Membership	£ Stlg	US $	€ Euros
A	BGCI Patron Institution	5000	8000	7500
B	Institution member (budget more than US$2,250,000)	750	1500	1000
C	Institution member (budget US$ 1,500,000 - 2,250,000)	500	1000	720
D	Institution member (budget US$ 750,000 - 1,500,000)	350	700	500
E	Institution member (budget US$ 100,000 - 750,000)	185	370	265
F	Institution member (budget below US$100,000)*	85	170	125
	**Generally applies to institutions in less developed countries*			

Other Membership Categories:

Membership benefits depend on category - see below. These can include:

- Regular publications:
  - the regular newsletter, *Cuttings*
  - *BGjournal* - an international journal for botanic gardens (2 per year)
  - *Roots* - Environmental Education Review (2 per year)
- Invitations to BGCI congress and discounts on registration fees

	Individual Membership	£ Stlg	US $	€ Euros
J	Conservation donor (*BGjournal*, *Roots* and *Cuttings* plus more)	250	500	350
K	Associate member (*Cuttings* and *BGjournal*)	40	80	60
L	Associate member (*Cuttings* and *Roots*)	40	80	60
M	Friend (*Cuttings*) available through online subscription only (www.bgci.org)	10	20	15

*Contents of the Botanic Garden Management Resource Pack: *The Darwin Technical Manual for Botanic Gardens, A CITES Manual for Botanic Gardens, A Handbook for Botanic Gardens on the Reintroduction of Plants to the Wild, BGjournal - an international journal for botanic gardens (2 past issues), Roots - environmental education review (2 past issues), The International Agenda for Botanic Gardens in Conservation, Global Strategy for Plant Conservation, Environmental Education in Botanic Gardens, BG-Recorder (a computer software package for plant records).*

Payment may be made by cheque payable to Botanic Gardens Conservation International, or online at www.bgci.org or by VISA/Mastercard sent to BGCI, Descanso House, 199 Kew Road, Richmond, Surrey, TW9 3BW, U.K or Fax: +44 (0) 20 8332 5956.

❑ I wish to apply for membership of Botanic Gardens Conservation International.

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❑ I would like to make a donation to BGCI. Amount . . . . . .

Please clearly state your name (or the name of your institution) on all documentation. Please contact info@bgci.org for further information.

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