INCORPORATING AND UTILISING SPATIAL DATA AND MAPPING FOR NBSAPS

ANNEX:
RESOURCE INFORMATION SHEETS

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This annex originates from a joint UNEP-WCMC and BirdLife International project, undertaken to provide guidance to support National Biodiversity Strategies and Action Plan (NBSAP) practitioners in 'Incorporating and utilising spatial data and mapping for NBSAPs'.

**Lead Authors**

Nadine Bowles-Newark, Andrew Arnell, Anna Chenery, Claire Brown, Neil Burgess (UNEP-WCMC), Stuart Butchart (BirdLife International).

**Contributing Authors**

Robert Smith (University of Kent), Sarah Knight, Brian O’Connor, Brian MacSharry, Siobhan Kenney (UNEP-WCMC), Stuart Butchart, Melanie Heath, Ian May, Lincoln Fishpool, Leon Bennun, Ben Lascelles, Jenny Birch, John Cornell, Tris Allison, Carolina Hazin, (BirdLife International), Graeme Buchanan (RSPB).

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**Citation**


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CONTENTS

Three stage guide to choosing resources for incorporating spatial data and mapping 4
Thematic areas with resource information sheets and corresponding categories and temporal considerations 6

RESOURCE INFORMATION SHEETS

Conservation International Biodiversity Hotspots 9
Udvardy’s Biogeographical Provinces 11
WWF Ecoregions 13
ARTificial Intelligence for Ecosystem Services (ARIES) 15
Costing Nature 17
Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) 19
Toolkit for Ecosystem Service Site-Based Assessments (TESSA) 21
Alliance for Zero Extinction (AZE) sites 23
Critical Site Network Tool for Waterbird Conservation 25
Global inventory of marine Important Bird and Biodiversity Areas (IBAs) 27
Integrated Biodiversity Assessment Tool for Research and Conservation Planning (IBAT for R&CP) 29
Map of potential sensitivity of birds to wind energy development 31
Global Land Cover 2000 33
IDRISI Selva Land Change Modeler (LCM) 35
Land cover change rapid assessment tool 37
Terra-i 39
Dyna-CLUE 41
Globiom 43
Land Systems Map 45
World Database on Protected Areas (WDPA) 47
Global Biodiversity Information Facility (GBIF) 49
IUCN Red List 51
Spatial projections for species distributions under climate change 53
Threatened Island Biodiversity Database 55
Marxan 57
THREE STAGE GUIDE TO CHOOSING RESOURCES FOR INCORPORATING SPATIAL DATA AND MAPPING

<table>
<thead>
<tr>
<th>Stage 1: Identify time and technical expertise available</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category 1</strong></td>
</tr>
<tr>
<td><strong>Description:</strong> Utilises maps from existing global products in NBSAPs.</td>
</tr>
<tr>
<td><strong>Time required</strong>: Minimal</td>
</tr>
<tr>
<td><strong>Technical expertise:</strong></td>
</tr>
<tr>
<td>✓ Access to a computer with an internet connection</td>
</tr>
<tr>
<td>✓ Understanding of datasets</td>
</tr>
<tr>
<td>✓ Visual representation of results (e.g. screen shot)</td>
</tr>
<tr>
<td>✓ May require some limited GIS knowledge</td>
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</tbody>
</table>

| **Category 2** |
| **Description:** Produces new datasets from some level of analysis of global and national data. |
| **Time required**: Minimal to Medium |
| **Technical expertise:** |
| ✓ Access to a computer with an internet connection |
| ✓ Understanding of datasets |
| ✓ Software for analysis (e.g. GIS) |
| ✓ Intermediate knowledge of GIS |
| ✓ Some national datasets |

| **Category 3** |
| **Description:** Provides an in-depth analysis using (primarily) national datasets including, but not limited to, systematic conservation planning approaches. |
| **Time required**: Minimal to Significant |
| **Technical expertise:** |
| ✓ Access to a computer with an internet connection |
| ✓ Understanding of datasets |
| ✓ Software for analysis (e.g. GIS, statistical software) |
| ✓ Advanced knowledge of GIS |
| ✓ Multiple national datasets |

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Ω Time required to learn to use resource and apply. Minimal: 1-10 days. Medium: 1-6 weeks dependent on resource used. Significant: 3-9 months dependent on resource used.

¹ Some resources in the higher category may not necessarily be applicable for NBSAP reporting for many countries but have been included to give an idea of the range of approaches that might be used.
### Stage 2: Choose the type of resource

<table>
<thead>
<tr>
<th><strong>Dataset:</strong> These are typically spatial and stored in widely used data formats such as vector (e.g. ESRI shapefiles, MapInfo Tab) or raster (TIFF, GRID files) and can be opened and viewed using GIS software.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Online tools:</strong> These are browser-based (e.g. using Internet Explorer, Mozilla Firefox etc.) modelling and mapping tools (e.g. IBAT, Terra-i, Co$ting Nature). The main requirements are a computer with a fast enough internet connection.</td>
</tr>
<tr>
<td><strong>Software based:</strong> These may be stand alone software, or tools that plug in to existing GIS software, such as ArcGIS, MapInfo, or QGIS.</td>
</tr>
<tr>
<td><strong>Toolkits (Knowledge products):</strong> These provide specific advice and guidance for carrying out a particular task or series of tasks. These generally propose using specific methods and have particular aims in mind such as carrying out an assessment of a site.</td>
</tr>
<tr>
<td><strong>Analysis:</strong> Resources that can be used to analyse spatial data.</td>
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### Stage 3: Temporal considerations

<table>
<thead>
<tr>
<th><strong>Baseline:</strong> The resource under this category will present baseline data only.</th>
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<tbody>
<tr>
<td><strong>Temporal trends:</strong> The resource under this category highlights trends on a temporal scale.</td>
</tr>
<tr>
<td><strong>Future scenarios:</strong> Utilising the resource under this category will produce future scenarios.</td>
</tr>
</tbody>
</table>
### Thematic Areas with Resource Information Sheets and Corresponding Categories and Temporal Considerations

<table>
<thead>
<tr>
<th>Thematic area</th>
<th>Resource Information Sheet</th>
<th>Category</th>
<th>Type of resource</th>
<th>Temporal considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biogeographic regions</strong></td>
<td>Conservation International Biodiversity Hotspots (p9)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Udvardy's Biogeographical Provinces (p11)</td>
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<td></td>
<td>WWF Ecoregions (p13)</td>
<td>1</td>
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<tr>
<td><strong>Ecosystem services</strong></td>
<td>ARtificial Intelligence for Ecosystem Services (ARIES) (p15)</td>
<td>2</td>
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<td></td>
<td>Co$ting Nature (p17)</td>
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<td>Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) (p19)</td>
<td>2</td>
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<tr>
<td></td>
<td>Toolkit for Ecosystem Service Site-Based Assessments (TESSA) (p21)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Key Biodiversity Areas</strong></td>
<td>Alliance for Zero Extinction (AZE) sites (p23)</td>
<td></td>
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<tr>
<td></td>
<td>Critical Site Network for Waterbird Conservation (p25)</td>
<td>1</td>
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<td></td>
<td>Global inventory of marine Important Bird and Biodiversity Areas (IBAs) (p27)</td>
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<tr>
<td></td>
<td>Integrated Biodiversity Assessment Tool for Research and Conservation Planning (IBAT for R&amp;CP) (p29)</td>
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<td></td>
<td>Map of potential sensitivity of birds to wind energy development (p31)</td>
<td>1</td>
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<tr>
<td><strong>Land cover</strong></td>
<td>Global Land Cover 2000 (p33)</td>
<td>1</td>
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<td></td>
<td>IDRISI Land Change Modeler (p35)</td>
<td>2</td>
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<tr>
<td></td>
<td>Land cover change rapid assessment tool (p37)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Thematic area</td>
<td>Resource Information Sheet</td>
<td>Category</td>
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<tr>
<td>Land Cover</td>
<td>Terra-i (p39)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Land use and land use change</td>
<td>Dyna-CLUE (p41)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Globiom (p43)</td>
<td></td>
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<tr>
<td></td>
<td>Land Systems Map (p45)</td>
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<tr>
<td>Protected areas</td>
<td>IBAT for R&amp;CP (p29)</td>
<td></td>
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<tr>
<td></td>
<td>World Database on Protected Areas (WDPA) (p47)</td>
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<tr>
<td>Species distribution</td>
<td>Global Biodiversity Information Facility (GBIF) (p49)</td>
<td></td>
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<td>IUCN Red List (p51)</td>
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<td>Spatial projections for species distributions under climate change (p53)</td>
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<tr>
<td></td>
<td>Threatened Island Biodiversity Database (p55)</td>
<td></td>
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<tr>
<td>Systematic Conservation Planning</td>
<td>Global Land Cover 2000 (p33)</td>
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<td>Marxan (p57)</td>
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<td>WDPA (p47)</td>
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<td>WWF Ecoregions (p13)</td>
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What are Conservation International (CI) Biodiversity Hotspots?

Biodiversity, and the threats to it, are unevenly distributed across the globe. Therefore the hotspots approach aims to help prioritise areas with a high number of endemic plants that are considered under threat from habitat loss. Each hotspot must meet two criteria: contain at least 1,500 species of vascular plants (> 0.5% of the world’s total) as endemics; and have lost at least 70 percent of their original habitat. The original paper2 described 10 biodiversity hotspots, based upon criteria of plant endemism and habitat loss. This system was elaborated upon and adapted by Conservation International (CI) in 1989 as an institutional blueprint for conservation action3–4. A further analysis of hotspots resulted in a final list of 34 regions being identified across the world5. Between them these regions contain around 50% of the world’s endemic plant species and 42% of all terrestrial vertebrates. However these regions have lost around 86% of their original habitat.

What can they be used for in the context of NBSAPs?

◆ Noting their extent and value can be highly effective for gaining funds for conservation action.
◆ To convey the global biological importance of a particular geographic area within an accepted and established conservation framework.
◆ Descriptive lists and statistics for species within hotspots are available however priority areas within hotspots require further information.
◆ Boundaries are coarse and may not be appropriate for use in high resolution/landscape-scale analyses as they are intended for use at regional to global scales.

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User Inputs

- Download CI Biodiversity Hotspot data (GIS shapefiles format).
- Open dataset in GIS software (open shapefile and navigate to geographic area of interest).
- Choose style (select appropriate symbology and legend for display).

Outputs

- Maps of CI Biodiversity Hotspots.

Strengths

- High degree of overlap with other recognised prioritisation schemes, such as the World Wide Fund for Nature (WWF) Ecoregions.
- An established framework endorsed by large conservation bodies including the MacArthur and Moore Foundations, the World Bank, the Global Environment Facility and Conservation International.

Weaknesses

- Typically large geographic areas where further analyses are required for spatial prioritisation within hotspots (e.g. limited use for site-scale assessment and decision making).
- Not directly useful for NBSAPs in those countries that are not in, or near, hotspots.
- Hotspots were chosen using concentrations endemic plant species and although they house large numbers of other taxa, this bias should be noted.

Time Requirements

Time required to learn to use: <1 day
Time required to apply: ca. <1 day

Further resources

CI Biodiversity Hotspots shapefiles
http://www.conservation.org/where/priority_areas/hotspots/Pages/hotspots_main.aspx

The A to Z of biodiversity website
http://www.biodiversitya-z.org/
UDVARDY’S BIOGEOGRAPHICAL PROVINCES (1975)

<table>
<thead>
<tr>
<th>Aichi Biodiversity Targets</th>
<th>Tier</th>
<th>Type of resource</th>
<th>Temporal considerations</th>
</tr>
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<tbody>
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<td>15</td>
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</table>

**What are Udvardy’s Biogeographical Provinces (1975)?**

Biogeographic Provinces are geographical units that aim to act as a framework for conserving the distribution of species and ecosystems. The framework is organised into a hierarchical system of biogeographical entities, consisting of 8 Realms (continent or sub-continent-sized areas with unifying phylogenetic sub-divisions), 14 Biomes (combine features of major vegetation type with climate) and 186 Provinces (delimited on a faunal, floral and ecological basis).

**What can they be used for in the context of NBSAPs?**

◆ Producing descriptive maps that highlight a country or area of interest in a global biogeographical perspective.

◆ Providing descriptions for major demarcations based on a combination of ecology and climate.

◆ They are not appropriate for fine-scale analysis.

**User Inputs**

◆ Download Biogeographical Provinces data (GIS shapefiles).

◆ Open dataset in GIS software (open shapefile and navigate to geographic area of interest).

◆ Choose style (select appropriate symbology and legend for display).

**Outputs**

◆ Maps of Biogeographical Provinces showing the characteristics of an area of interest in a global context.

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Strengths

◆ Allows conservation planning to move away from reliance on geopolitical boundaries towards ecologically relevant boundaries.
◆ Provides a global biogeographic context for a specific region of interest.
◆ Established system with a comparatively long history which has undergone multiple updates.
◆ Transparent and repeatable methodology.
◆ Free and easy to download datasets.

Weaknesses

◆ This is a dated system and, when compared to more recent approaches such as WWF Ecoregions, the use in current conservation prioritisation is more limited.
◆ The scale of these large regions can make them hard to employ for practical conservation efforts, such as building protected area networks.
◆ As with other biogeographical regions, further analyses are required for spatial prioritisation within these regions.
◆ This approach may be less informative for smaller countries that may overlap with just one province.

Time Requirements

Time required to learn to use: <1 day
Time required to apply: ca. <1 day

Further resources

GIS shapefiles available from UNEP-WCMC


Acknowledgements

The Biogeographical Provinces dataset was prepared by IUCN for the United Nations Educational, Scientific and Cultural Organisation Man and Biosphere (UNESCO MAB) programme and is available to download online.

What are World Wildlife Fund for Nature (WWF) Ecoregions?

WWF defines an ecoregion as a “large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions”. WWF Ecoregions built on foundations of classic biogeography and were developed as broad planning units that were prioritised for conservation action. They were defined and mapped through: regional analyses of biodiversity patterns and processes; extensive consultation with experts; and thorough literature reviews. Ecoregions are grouped according to ecological realm (terrestrial, freshwater and marine), biogeographic realm (e.g. Australasia or the Afrotropics) and major habitat type (e.g. tropical forest). There are 867 Terrestrial, 232 Marine and 426 Freshwater ecoregions in total including the Madagascar Dry Forests, the Great Barrier Reef and the Sunderland Rivers and Swamps.

WWF has also highlighted a subset of 238 priority ecoregions, known as the Global 200, where effective conservation should help conserve the most outstanding and representative habitats for biodiversity8,9.

What can they be used for in the context of NBSAPs?

◆ Ecoregions are a logical biogeographic framework for the development of large-scale conservation strategies and provide a link between site-based assessments and global priority setting10, for example within the Global 200 Ecoregions.

◆ GIS datasets for terrestrial, freshwater and marine ecoregions can be freely downloaded. Information for each ecoregion, such as outstanding and distinctive biodiversity features, current status and types and severity of threats to the natural habitats, can be particularly useful for increasing biogeographic literacy and communicating conservation issues.

◆ Spatial prioritisation of specific areas within ecoregions would require extra information than currently provided by the WWF Ecoregions datasets.

◆ Boundaries are intended for use at regional to global scales and therefore may not be appropriate for use at high resolution or at a landscape-scale.

◆ The identification of an area as a Global 200 Ecoregion does not afford any legal protection.

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**User Inputs**
- Download ecoregion data: GIS shapefiles are available for Terrestrial, Freshwater and Marine ecoregions.
- Open dataset in GIS software (open shapefile and navigate to geographic area of interest).
- Choose style (select appropriate symbology and legend for display).

**Outputs**
- Maps showing the distribution and characteristics of the ecoregions within the area of interest.

**Strengths**
- Useful for setting conservation priorities and planning efforts at regional and global scales.
- Results are available from numerous published studies that use the ecoregion framework (e.g. the WWF Global 200, or the Living Planet Index (LPI)\textsuperscript{11}).
- An established framework that is recognised by the Convention on Biological Diversity (CBD) and endorsed by large conservation organisations, including WWF and The Nature Conservancy.
- Allows conservation planning to move away from reliance on geopolitical boundaries towards based ecologically relevant boundaries.
- Sufficient biogeographic resolution to accurately reflect the complex distribution of the Earth’s natural communities\textsuperscript{12}.

**Weaknesses**
- Further analyses are required for spatial prioritisation within ecoregions.
- The approach may be less informative for smaller countries that may overlap with just one ecoregion.

**Time Requirements**
- Time required to learn to use: <1 day
- Time required to apply: ca. <1 day

**Further resources**
- **A to Z of biodiversity**
  http://www.biodiversity-a-z.org/areas/14
- **Marine Ecoregions of the World GIS shapefile**
- **Terrestrial Ecoregions of the World GIS shapefile**
- **Freshwater Ecoregions of the World data and visualisation**

**Acknowledgements**

WWF Ecoregions was developed by the WWF in collaboration with regional experts around the world.


ARTIFICIAL INTELLIGENCE FOR ECOSYSTEM SERVICES (ARIES)

### Aichi Biodiversity Targets

<table>
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<tr>
<th>Tier</th>
<th>Type of resource</th>
<th>Temporal considerations</th>
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</table>

**Scale:** Sub-national to Global  **Access:** Open (for non-profit applications)  **Language:** English

What is Artificial Intelligence for Ecosystem Services (ARIES)?

ARIES maps and values ecosystem services and assesses the impacts of land use on them. ARIES is a software application that supports ecosystem service assessment and valuation which builds models of supply and demand for ecosystem services from stored component models, and simulates the dynamic flow of benefits spatially. It is able to accommodate component models that work at different scales and use different forms of input data, measurement units and modelling paradigms.

What can it be used for in the context of NBSAPs?

- ARIES allows for consideration of ecosystem services in the decision making process. Specifically, the tool allows mapping of areas that are important for ecosystem services and biodiversity in order to quantify service flows and to value the resulting benefits in terms of different monetary and nonmonetary criteria.

- Aries can be run for a number of land use scenarios so as to reflect different biodiversity and ecosystem service management options. This can assist in evaluating trade-offs and in prioritising where and how to manage habitats, species and services.

- ARIES requires training to run a new case study so therefore cannot be used immediately for any region in the world.

- ARIES does not calculate value, the user must define it as an input.

**User Inputs**

- Stakeholder engagement (for identification of services and beneficiaries, and for the development of scenarios).

- GIS data such as: carbon stocks; land cover; land uses; vegetation; soil; deforestation risk; infrastructure; population; hydrology; floodplains; elevation; water extraction; and areas of service use and demand.

**Outputs**

- Maps of ecosystem service source, sink, use and flow under baseline conditions or user-defined scenarios.
**Strengths**

◆ Can be used as a web-based service (once defined and composed, ARIES models can be run remotely through any web browser).

◆ ARIES includes probabilistic Bayesian models that quantify the uncertainty of their outputs based on the uncertainty of input data and can operate in data scarce conditions where deterministic models cannot run. ARIES models actual flows of benefits dynamically.

◆ ARIES automatically chooses different models depending on data availability and social and ecological context.

**Weaknesses**

◆ So far ARIES is only calibrated for 7 geographic case studies on 8 ecosystem services with no biodiversity module available yet. Generalized models are under development.

◆ The development of ecosystem service models for new case studies requires modelling expertise. The web interface is still at a demonstrational stage.

◆ The economic valuation module is still under development.

**Time Requirements**

Time required to learn to use: 2-3 weeks  
Time required to apply: 1-2 weeks  
Development of new modules and case studies: Depends on data availability and desired quality of results. This cannot be done using the web interface, however, training is available.

**Further resources**

ARIES Modelling Guide  
ARIES Case Studies  
ARIES Publications  
http://www.ariesonline.org/resources.html

**Acknowledgements**

The ARtificial Intelligence for Ecosystems Services application was developed with funding from the National Science Foundation at the University of Vermont’s Gund Institute for Ecological Economics; and is sponsored by NSF, UNEP-WCMC, the University of Vermont, Conservational International, Earth Economics, the Basque Centre for Climate Change and the Instituto de Ecologia, A.C.
What is Co$ting Nature?

Co$ting Nature calculates the spatial distribution of ecosystem services for water, carbon, hazard mitigation and tourism and combines these with maps of conservation priority, threatened biodiversity and endemism to understand the spatial distribution of critical ecosystems. The tool identifies the potential and realised services. These data are combined with analysis of current human pressures and future threats on ecosystems and their services in order to assess conservation priorities\(^{13}\).

What can it be used for in the context of NBSAPs?

- Co$ting Nature is a powerful tool in identifying priority service areas as it effectively ranks locations across the grid cells, across a user-defined area or across global values.
- It can also be used to assess the potential and use of ecosystem services in relation to conservation priority areas.
- Co$ting Nature does not put monetary value on ecosystem services and therefore cannot be used in this type of valuation.
- Many input layers are not available for download as raw data as they are protected by licenses.

**User Inputs**

- Choose region of interest.
- Choose extent/resolution.
- Option to add supplementary data (paid licence only).
- Option for climate change and land use scenario modelling (paid licence only).

**Outputs**

- Gridded layers of potential and realised ecosystem services at 1km or 1ha grid cell resolution normalised as an index to local or global ranges.

**Strengths**
- Accounts for demand of services as well as supply.
- All data is supplied.
- Outputs can be exported in a variety of formats.

**Weaknesses**
- Uses a limited range of ecosystem services.
- Currently does not have scenarios for climate change or land use, without paid licence.
- Limited to the ecosystem services that can currently be globally mapped.

**Time Requirements**
- Time required to learn to use: <1 day
- Time required to apply: <1 day

**Further resources**

**Costing Nature Example Applications**
http://www.policysupport.org/costingnature/example-applications

**Costing Nature Main Publication**
http://www.unep.org/pdf/Framing_the_Flow_lowres_2ofinal.pdf

**Acknowledgements**
Costing Nature was developed by King’s College London, Ambio TEK and UNEP-WCMC.
INTEGRATED VALUATION OF ECOSYSTEM SERVICES AND TRADEOFFS (InVEST)

Aichi Biodiversity Targets Tier Type of resource Temporal considerations

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Scale: Landscape to Global Access: Open Language: English

What is Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST)?

InVEST is a set of spatially explicit models that can be used to quantify, map and value the benefits provided by terrestrial, freshwater and marine ecosystems in either biophysical terms (e.g. tons of carbon sequestered) or economic terms (e.g. Net Present Value of sequestered carbon). It can be used to map the relative importance of different areas for ecosystem services including; (i) carbon storage and sequestration; (ii) provision of habitat for biodiversity; (iii) water purification; (iv) sediment retention; (v) timber production; and (vi) crop yield.

What can it be used for in the context of NBSAPs?

◆ InVEST demonstrates the impacts on economies, human well-being and the environment under different resource management strategies.

◆ InVEST can apply scenarios and models to predict impacts of land management plans on ecosystem services. In the context of NBSAP planning, this tool could be useful for assessing impacts on ecosystem services and their economic values under different baseline and management strategies.

◆ InVEST allows the assessment of the trade-offs between different ecosystem services under user-defined scenarios. Consequently, it is a useful tool to evaluate where and how to implement NBSAPs so as to benefit human well-being and biodiversity.

◆ InVEST is based on deterministic models and therefore loses accuracy when used in areas where ecological processes are not understood.

User Inputs

◆ Stakeholder input (for development of scenarios).

◆ GIS data (input layers to models e.g. carbon, water).

Outputs

◆ Trade-off maps, trade-off curves and balance sheets of ecosystem service provision described in economic and biophysical terms.


**Strengths**

- Applicable to all regions globally.
- Widely peer-reviewed, with good user documentation and guidance available as well as case studies.
- Open access software which is downloadable online and compatible with ArcGIS software.
- Flexible and tiered approach allows the user to use appropriate level of complexity.
- Based on sophisticated ecological modelling modules.

**Weaknesses**

- Production function approach oversimplifies the biophysical cycles and relationships.
- InVEST requires large amounts of data which is time consuming to parameterise (although the tiered approach attempts to address this) and results are very sensitive to data quality.
- Economic values are calculated based on avoided damages, so that not all aspects of ecosystem service values can be considered.

**Time Requirements**

- Time required to learn to use: 2-3 weeks
- Time required to apply: ca. 2-3 weeks
- Collection and preparation of input data: Up to several months, depending on data availability

**Further resources**

InVEST user manual
http://ncp-dev.stanford.edu/~dataportal/invest-releases/documentation/current_release/

Natural Capital Project Publications
http://www.naturalcapitalproject.org/publications.html

**Acknowledgements**

InVEST was developed by The Natural Capital Project.
What is the Toolkit for Ecosystem Service Site-based Assessments (TESSA)?

TESSA provides practical guidance on how to measure and monitor a number of ecosystem services at the site scale with limited input of time and resources, and how to assess the potential impacts of changes in land use on these services. It helps the user to decide which services to include in the assessment, what methods to use, and how to communicate the results. The proposed methods are designed to produce scientifically robust results that can provide preliminary information on the socio-ecological impacts of land use decisions to decision makers. Use of the toolkit can help to identify areas where more detailed studies would be useful (e.g. for establishing Payments for Ecosystem Services schemes).

What can it be used for in the context of NBSAPs?

◆ In many countries there is little information on the current status of ecosystem services at either the local or national level, as required to address Aichi Biodiversity Target 14. There is even less knowledge about the likely impacts of continued land cover change on providing these services. The toolkit helps users to carry out a rapid assessment of the current and likely future status of ecosystem services at multiple key sites (such as protected areas), and hence to inform the actions required to safeguard them.
◆ By combining spatial data for sites (e.g. protected areas from the WDPA, or Key Biodiversity Areas (KBAs) from IBAT for R&CP) with ecosystem-service evaluations using TESSA at such sites, users could map the spatial distribution of ecosystem service delivery and potential changes in this under a business-as-usual scenario.
◆ Currently only applicable for a subset of ecosystem services.
◆ It is intended for use at a site level, therefore not for use at national scales and above.

User Inputs

◆ Identification and quantification of key habitats that are important for the provision of ecosystem services and that might undergo changes in land use.
◆ Identification of ecosystem services that are likely to be affected by changes in land use, and of stakeholder groups that benefit from those services.
◆ Identification of plausible future scenarios of developments in land use (e.g. business as usual versus implementation of forest restoration activities)
**Outputs**

◆ An assessment of the provision and value of each ecosystem service in the current state of the landscape and possible alternative states.

◆ Identification of the consequences of changes in land use for different groups of stakeholders (i.e. identification of ‘winners’ and ‘losers’).

**Strengths**

◆ The toolkit is designed to fit different levels of capacity and available resources, and provides methods and recommendations for collection of primary data or use of remotely collected information where collection of field data isn’t feasible.

◆ By including an assessment of beneficiaries in the analysis, the toolkit can help to raise awareness of the socio-economic implications of land use choices for different stakeholders, something which is overlooked by many other similar tools.

**Weaknesses**

◆ The toolkit currently provides methods for the assessment of a limited number of ecosystem services, these include: global climate regulation; water provision and quality; harvested wild goods; cultivated goods; and nature-based recreation.

◆ Modules covering coastal protection, pollination and cultural services are currently in development.

**Time Requirements**

Time required to learn to use: ~1 week
Time required to apply: 2-3 months

**Further resources**

Download a scientific paper describing the approach and methods (Peh et al. 2013): TESSA: A toolkit for rapid assessment of ecosystem services at sites of biodiversity conservation importance
http://dx.doi.org/10.1016/j.ecoser.2013.06.003

Download a summary booklet profiling the toolkit: http://www.birdlife.org/datazone/sowb/sowbpubs#Ecoservices2011

Download a national assessment of the ecosystem services provided by IBAs in Nepal which used some of the methods in the toolkit: http://www.birdlife.org/datazone/sowb/sowbpubs#Ecoservices2012

**Acknowledgements**

The Toolkit for Ecosystem Service Site-based Assessment (TESSA) has been compiled by Anglia Ruskin University, BirdLife International, Cambridge University (Geography and Zoology Departments), Royal Society for the Protection of Birds, Tropical Biology Association and UNEP-WCMC.
What is the Alliance for Zero Extinction (AZE)?
AZE sites are identified as all sites worldwide holding the sole remaining population of any species listed as Critically Endangered or Endangered on the IUCN Red List. AZE provides spatial and tabular data on the 587 sites supporting the last remaining populations of one or more of 920 species of mammals, birds, amphibians, reptiles, conifers and reef-building corals. The database is searchable by species or country through text fields and an interactive map.

What can it be for used in the context of NBSAPs?
◆ AZE sites represent priorities for effective conservation. By definition, they represent locations where national governments have sole responsibility for ensuring the survival of an entire species.
◆ AZE sites represent places where governments may consider establishing or expanding protected areas, and ensuring these are managed effectively to ensure the survival of the AZE species.
Effective protection and management of AZE sites provides an important contribution to meeting Aichi Biodiversity Target 11 and is essential for meeting Aichi Biodiversity Target 12. Given that loss or conversion of AZE sites would automatically cause the global extinction of the species for which they are identified, effectively conserving these places is important for meeting Aichi Biodiversity Target 12.

User Inputs
◆ Choose geographic area of interest.

Outputs
◆ List of Critically Endangered and Endangered species restricted to single sites.
◆ Digital boundaries of such sites.
**Strengths**

◆ The strength of the concept is the simplicity and utility for prioritising action.

**Weaknesses**

◆ At present not all species have been assessed for the IUCN Red List, so many species of reptiles, fish, invertebrates and plants that would qualify as AZE species need to be assessed for the IUCN Red List first.

**Time Requirements**

Time required to learn to use: <1 day  
Time required to apply: ca. <1 day

**Further resources**

*Scientific paper* describing the approach and dataset (Ricketts et al., 2005):  
*Pinpointing and preventing imminent extinctions*  
http://www.pnas.org/content/102/51/18497.full.pdf

*Scientific paper* assessing the degree of protection of AZE sites (Butchart et al., 2012):  
*Protecting Important Sites for Biodiversity Contributes to Meeting Global Conservation Targets*  
http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0032529

*Booklet* profiling how data from birds can be useful for NBSAPS: BirdLife International (2012)  
Developing and implementing National Biodiversity Strategies and Action Plans: How to set, meet and track the Aichi Biodiversity Targets.  
http://www.birdlife.org/datazone/sowb/sowbpubs#NBSAP2012

**Acknowledgements**

Alliance for Zero Extinction sites is a collaboration between 88 non-governmental biodiversity conservation institutions, involving 93 members from 37 countries; partners of which are listed at  
http://www.zeroextinction.org/partners.html
**What is the Critical Site Network (CSN) tool for waterbird conservation?**

The CSN tool for Waterbird Conservation is a portal designed to help decision makers and planners at the local, national and international level identify which places are part of the critical network of sites required for conservation of waterbirds. It covers over 300 waterbird species in Africa and Eurasia and provides information on ‘critical sites’ (i.e. those important during each stage of the annual cycle when a site-based conservation approach is effective). Sites are identified using quantitative criteria based on up-to-date knowledge of the sizes and trends of bird populations.

**What can it be used for in the context of NBSAPs?**

- Migratory waterbirds require particular conservation measures in order to address Aichi Biodiversity Targets 11 and 12. Most populations of migratory waterbirds are tightly constrained by ecological factors in their breeding, wintering and/or stopover areas. Many sites are needed along the entire migration routes of these birds to maintain their populations. This complex web of sites form a chain in which each link is essential for maintaining viable and healthy populations of migratory waterbirds along the entire network. The protection of such a network of critical sites therefore requires concerted national and transboundary conservation actions. Identifying key sites and maintaining their ecological functions and services along the entire migration route provides the basis for successful flyway-scale conservation. The CSN tool helps to identify such sites, which governments may consider as priorities for establishing or expanding protected areas, thereby ensuring the effective management of these areas for the survival of the relevant waterbird species. The CSN tool helps decision makers and planners at the local, national and international level identify which places are part of the critical network of sites for specific waterbirds.

**User Inputs**

- Choose geographic area or species of interest.
- Choose map layers of interest.

**Outputs**

- Map of critical sites for each waterbird species at each stage of its breeding cycle, including those sites not yet identified as IBAs, or not yet formally protected.
**Strengths**

- For a subset of species and countries, it provides a powerful tool to help governments identify priorities for conservation interventions to safeguard these key sites and the important species they support.

**Weaknesses**

- The CSN tool is specifically focused on waterbirds (in particular those relevant to the African-Eurasian Migratory Waterbird Agreement (AEWA)).
- It is currently restricted to the AEWA region only.

**Time Requirements**

- Time required to learn to use: <1 day
- Time required to apply: <1 day

**Further resources**

- A video on the CSN tool: [http://www.youtube.com/watch?feature=player_embedded&v=P1X5GBvEu7g](http://www.youtube.com/watch?feature=player_embedded&v=P1X5GBvEu7g)
- Wings over Wetlands project: [http://www.wingsoverwetlands.org/](http://www.wingsoverwetlands.org/)

**Acknowledgements**

The Critical Site Network for Waterbird Conservation was developed through the ‘Wings over Wetlands’ project involving: the African-Eurasian Migratory Waterbird Agreement (AEWA); the Ramsar Convention on Wetlands; Wetlands International; Birdlife International; UNEP-WCMC; and a range of local partners along the African-Eurasian Flyway. The project was supported financially and technically by the Global Environment Facility (GEF), UNEP, Bundesamt fur Naturschutz (BfN) and others.
What is the Global inventory of marine Important Bird and Biodiversity Areas (IBAs)?

The Global inventory of marine IBAs is an e-Atlas covering 3,000 IBAs worldwide. Sites have been identified as priorities for marine conservation based on the key populations of over 350 seabird species contained within them. The project has focused on understanding seabird life-cycles and identifying those areas where birds are thought to congregate in the greatest numbers and be at their most vulnerable to threats. The types of site that qualify as marine IBAs therefore include seabird breeding colonies, foraging areas around breeding colonies, non-breeding (usually coastal) concentrations, migratory bottlenecks and feeding areas for pelagic species.

The data is searchable by species or country via an interactive map, while also dynamically linking to case studies regarding threats and actions of relevance to species and/or sites.

What can it be used for in the context of NBSAPs?

◆ The e-Atlas provides essential information for: conservation practitioners and policy makers; energy sector planners (wind farms, gas and oil exploration and drilling); fisheries managers; marine pollution management planners; and the insurance industry.

◆ Sites represent exceptional priorities for effective marine conservation and represent locations where national governments may consider establishing or expanding protected areas. Effective protection and management of these sites plays an important contribution to meeting Aichi Biodiversity Target 11 and Aichi Biodiversity Target 12.

◆ It is also crucial to the process of describing ecologically or biologically significant marine areas (EBSAs) under the CBD.

<table>
<thead>
<tr>
<th>User Inputs</th>
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</thead>
<tbody>
<tr>
<td>Species of interest.</td>
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<tr>
<td>Area of interest.</td>
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<tr>
<td>Other map layers.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of sites where seabirds meet IBA criteria.</td>
</tr>
<tr>
<td>Digital boundaries of such sites.</td>
</tr>
</tbody>
</table>
Strengths

◆ Global coverage with inputs from many countries ensures consistency and comparability of site selection at multiple scales.
◆ Simple to use.

Weaknesses

◆ Does not include all sea bird tracking data in existence.
◆ Some geographic gaps.
◆ Updating of some data is required.

Time Requirements

Time required to learn to use: <1 day
Time required to apply: <1 day

Further resources

BirdLife International Seabird Foraging Range Database
http://seabird.wikispaces.com/

BirdLife International Tracking Ocean Wanderers Database
http://www.seabirdtracking.org/

Acknowledgements

The Global Inventory of marine IBAs was developed by the BirdLife International; involving around 40 BirdLife Partners along with the world’s leading seabird scientists from inside and outside the Birdlife Partnership, government departments and the secretariats of several international conventions (CBD, EU Bird’s Directive and Nairobi Convention).
What is the Integrated Biodiversity Assessment Tool for Research and Conservation Planning (IBAT for R&CP)?

IBAT for R&CP is an innovative web-based tool designed to facilitate access to a range of global and national data layers. These layers include protected area boundaries, biological information about habitat and species diversity indices, and key areas for biodiversity (priority sites for conservation), which can be useful for research and conservation planning purposes.

What can it be used for in the context of NBSAPs?

◆ IBAT for R&CP can be used during NBSAP revision processes to access information about important species, habitats, and other biodiversity indices.

◆ The tool is designed to support biodiversity conservation decisions and planning and has been developed to include a map viewer allowing the user to view and query the core datasets linking through to further information where available. For example users can quickly identify sites of importance for biodiversity conservation on the map and then explore the underlying data on sites themselves and the species they’re important for, including descriptions, threats level of protection and the species IUCN status amongst others.

◆ The tool includes summary information tailored to NBSAP revision and implementation at the national/territorial level built on the underlying threatened species, protected areas and KBA data available through the tool. IBAT for R&CP users are encouraged to use the tool for the development or revision of NBSAPs making use of the biodiversity information it contains.

◆ IBAT for R&CP provides a platform for sharing data and information that can benefit regional and global analysis regarding Aichi Biodiversity Targets in the Strategic Plan for Biodiversity 2011-2020.
**User Inputs**
- Selection of datasets and area of interest.

**Outputs**
- Legally protected areas.
- Internationally recognised areas.
- Priority sites for biodiversity conservation.
- Regions of conservation importance.
- Threatened species distributions.

**Strengths**
- IBAT for R&CP describes and displays sites across the globe and its data are updated with the very latest available information frequently.
- IBAT for R&CP brings together information on protected areas, priority sites for biodiversity conservation, and threatened species from disparate databases managed by different institutions into a single tool to improve usability.

**Weaknesses**
- The tool is designed to give an overview of data analysed from a variety of global sources and as such is reliant on the quality and timeliness of the data made available to the underlying systems and institutions.

**Time Requirements**
- Time required to learn to use: <1 day
- Time required to apply: <1 day

**Further resources**
IBAT homepage containing background information
https://www.ibat-alliance.org/ibat-conservation/login

**Acknowledgements**
The IBAT for Research and Conservation Planning is one output of a partnership among BirdLife International, Conservation International, IUCN and UNEP-WCMC and is made possible by a set of data providers, users and funders in government, business and civil society from over 200 countries and territories.
What is the Map of potential sensitivity of birds to wind energy development?

Wind energy is critical for delivery of renewable and low-carbon energy. However, inappropriately sited wind energy developments can pose a major threat to some bird species. For example, over 2 million individual soaring birds migrate through the Red Sea/Rift Valley on their way to and from breeding grounds in Europe and Central Asia, but this region is also subject to huge development pressures, with increased demands for energy. Migratory soaring birds are particularly vulnerable to collision with wind turbines and associated power infrastructure, or to displacement. The reliance of soaring birds on thermal air currents to travel long distances means that their migration routes are constrained and the vast majority of a population may funnel along these routes and through bottleneck sites during migration. The tool helps wind energy developers and government planning authorities to access information on the distribution of soaring bird species, and to visualise and report on the relative sensitivity of different areas. It therefore facilitates the identification of the most appropriate locations for wind energy developments through avoiding those sites that are potentially sensitive locations for birds.

What can it be used for in the context of NBSAPs?

◆ The tool helps governments to achieve Aichi Biodiversity Target 2, by utilizing scientific data to directly inform development decision making. It also contributes to achieving Aichi Biodiversity Target 12.

◆ More generally, it can also help to make a contribution to the achievement of many of the other targets, through helping to ensure that infrastructure development and energy policy take biodiversity conservation into account.

User Inputs

◆ Choose geographic area of interest.

Outputs

◆ Searchable map of the potential sensitivity of birds to wind energy developments.
Strengths

◆ Within Rift Valley / Red Sea flyway, this tool provides a powerful tool to help businesses and governments identify the most appropriate locations for wind energy developments, through avoiding those sites that are potentially sensitive locations for birds.

Weaknesses

◆ Currently only available for the Rift Valley / Red Sea flyway.

Time Requirements

Time required to learn to use: <1 day
Time required to apply: <1 day

Further resources

The Migratory Soaring Birds project
http://migratorysoaringbirds.undp.birdlife.org

Species factsheets for all bird species
http://www.birdlife.org/datazone/species

Guidance for governments on wind energy development and bird conservation

Acknowledgements

The map of the potential sensitivity of birds to wind energy development has been developed as part of the UNDP/GEF Migratory Soaring Birds project facilitated by BirdLife International with fundamental contributions from national partners and independent organisations.
What is Global Land Cover 2000 (GLC 2000)?

GLC 2000 is a freely available global land cover dataset for the year 2000. The product has a resolution of 1 km and was derived using daily data from the VEGETATION sensor on-board the SPOT 4 satellite\(^{16}\). The product uses the FAO Land Cover Classification System (LCCS), one of the most flexible and useful approaches for dealing with the complexity of habitat description\(^{17}\). The global scale legend GLC 2000 has 22 land cover classes, but more detailed regional scale legends can be used that may be more appropriate for use in an NBSAP. This is possible as GLC 2000 was created from various regional datasets and uses a hierarchical classification system.

What can GLC 2000 be used for in the context of NBSAPs?

- The GLC 2000 dataset is downloadable as a raster layer that can be viewed and manipulated using GIS software to produce a map of land cover for the year 2000. Such maps can provide a useful overview of the broad habitat types and their distribution within a country, particularly useful for areas without more detailed land cover products.

- As with other global land use products some of the most pertinent uses for GLC 2000 are when used with other datasets for ecological modelling, such as in land use modelling.

- Should not be used to measure change over time by comparing to other products due to variation in techniques used to produce GLC 2000 and variation compared with other products.

User Inputs

- Download dataset (downloadable Raster data available online).
- Open dataset layer including legend within GIS software (e.g. ArcGIS/QGIS).
- Format layout and legend styles as required.

Outputs

- Thematic land cover map with legend.

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**Strengths**

- GLC 2000 conforms to the FAO Land Cover Classification System (LCCS) (endorsed as a unique and universal standard for classification of land cover). GLC 2000 is derived from regional products adapted to the local context.
- Built to be relevant for ecological studies and the Millennium Ecosystem Assessment in particular. Further land cover classes available with regional products.
- Useful for global comparisons and widely used in modelling of species distributions.
- Reported classification accuracy of 68.5% (±5%) that is competitive with other global land cover products.

**Weaknesses**

- Relatively coarse resolution (1km).
- Relatively dated product.
- Static product for year 2000 only which does not allow mapping of change over time.
- Lower accuracy than other global land cover products, e.g. MODIS and GlobCover.

**Time Requirements**

Time required to learn to use: <1 day
Time required to apply: ca. <1 day

**Further resources**

GLC2000 product information page on the Joint Research Council website

GLC2000 product download page

Geo-Wiki project with tools to compare land cover products and for crowd source validation
http://www.geo-wiki.org/

**Acknowledgements**

GLC 2000 was produced by an international partnership of 30 research groups coordinated by the European Commission Joint Research Centre (JRC).

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IDRISI SELVA LAND CHANGE MODELER (LCM)

Aichi Biodiversity Targets  | Tier  | Type of resource | Temporal considerations
--- | --- | --- | ---
5 | 10 | 11 | 12 | 15

**Scale:** Sub-national to Global
**Access:** Commercial
**Language:** English

**What is IDRISI Selva Land Change Modeler (LCM)?**

IDRISI Selva Land Change Modeler (LCM) is a land use planning and decision support software tool that allows for analysis of past land cover change. In addition this tool allows for development of scenarios of future land use change, species distribution modelling, and assessment of land use change impacts on habitats and biodiversity. IDRISI LCM also features tools that can develop deforestation baselines and models of future deforestation for use at a project level.

**What can it be used for in the context of NBSAPs?**

The land cover change analysis can be used to assess the nature of change between two land cover maps of different dates, in order to:

- understand historical deforestation trends
- identify drivers of land use change
- model future scenarios. IDRISI LCM also has an interface for MaxEnt and Marxan.

An accuracy assessment should be carried out and accuracy known for each input classification map.

**User Inputs**

- Land cover - Two land cover maps of different dates of known accuracy.
- Transitions of Interest - Data on the variables which drive the type of transition(s) taking place (e.g. slope of the terrain, distance to water sources, roads, and previously developed land).
- Interventions - Including constraints and incentives, such as land use zoning, and planned changes both in infrastructure (e.g. new roads) and land use options (e.g. proposed reserved areas).

**Outputs**

- Land cover pattern and change analysis.
- Species-specific habitat assessment.
- Habitat change analysis.
- Analysis of environmental variables for the refinement of species distribution.
- Species distribution modelling.
- Biodiversity assessments.
Strengths

◆ Features a robust tool to simulate deforestation trends which can support emissions reduction for Reducing Emissions from Deforestation and Forest Degradation (REDD+) initiatives.

◆ Takes advantage of IDRISI’s suite of Remote Sensing and GIS analytical tools.

◆ An integrated interface to other conservation and land use planning software (e.g. Marxan and MaxEnt). LCM is also available separately as an extension to ESRI’s ArcGIS product.

◆ A full documentation description and tutorials with datasets to facilitate the learning process.

Weaknesses

◆ Preparation of the input files requires good knowledge of raster formatting, general IDRISI functions and/or the ArcGIS interface.

◆ Requires users to acquire comparable cloud free satellite imagery from different time periods.

◆ Full access to the LCM is not open (although a trial version exists), general users will pay 1,250USD for the IDRISI software, which includes LCM. However, discounted pricing is available for academics and users in developing countries.

Time Requirements

Time required to learn to use: 1 day
Time required to apply: ca. 5 weeks

Further resources

IDRISI LCM for ArgGIS

The Land Change Modeler for Ecological Sustainability

Species Distribution Modeling in IDRISI’s Land Change Modeler
http://clarklabs.org/about/upload/Focus_Paper_Species.pdf

Video Resources
http://clarklabs.org/resources/videos.cfm

Acknowledgements

IDRISI Land Cover Modeler was developed by Clark Labs.
What is the land cover change rapid assessment tool?

This is a web-based monitoring tool for making rapid assessments of land cover change across sites such as protected areas, KBAs and IBAs. There are two versions: the first requires that users visually estimate the broad land cover type in 300m sample squares arranged systematically across sites from Landsat satellite images; the second performs semi automated classifications that allow users to correct errors by visual assessment producing a wall-to-wall classification. Simultaneous viewing of images from multiple time periods allows changes in land cover to be identified rapidly and with confidence. Users can estimate the proportions of up to three landcover types in a sample and can record the uncertainty associated with each estimate. The tool is therefore relevant to tracking land cover change, agricultural expansion, and effectiveness of protected areas and conservation status of species while allowing the recording of uncertainty associated with each estimate.

What can it be used for in the context of NBSAPs?

◆ At the site level, this monitoring tool can be used to make a rapid assessment of the pressures on sites, quantifying the change in land cover and identifying the location of loss of natural land cover.

◆ At the national level, compilation of statistics can be used to produce indices of the state of sites of conservation importance and likely impacts upon species that rely upon these sites.

◆ At the regional level, using a standardised tool with standardised classifications enables regional monitoring statistics to be compiled to produce regional indicators of trends and patterns of land cover change (=habitat loss).

◆ These assessments can be used to target conservation resources to sites which are under particular pressure, and develop appropriate interventions in a rapid manner. The tool can also be used to assess the effectiveness of interventions, including designation of protected areas, allowing refinement of interventions as appropriate.

◆ The tool can only measure pressures on biodiversity that relate to land cover change, and not threats such as from hunting or invasive species.

◆ It cannot be used to differentiate subtle difference in land cover (i.e. different types of grassland).

◆ It cannot be used to measure carbon stocks. It is designed to look at small areas, and is not appropriate for assessments of entire regions or continents, but rather networks of sites within these larger spatial units.
User Inputs
◆ Choose site of interest.
◆ Make visual assessment of land cover proportion and land cover change between dates.

Outputs
◆ Spatially referenced assessments of land cover and land cover change that can be used in a GIS, using either points or polygons. These are easy to amalgamate up spatial scales and are globally comparable.

Strengths
◆ Simple to use.
◆ Low capacity, with very little need for knowledge of remote sensing or expensive software.
◆ Enables citizen science.
◆ Rapid assessment.
◆ Systematic sampling ensures that the area of interest has an even distribution of sample points while the wall-to-wall tool allows total assessment of site (although the sample based approach is a statically robust method of assessing changes).

Weaknesses
◆ It requires a c. 2 – 3 week training period (training manuals are available).
◆ Functions online, so needs reasonable web connection.
◆ Cloud cover can obscure parts of images.

Time Requirements
Learning to use the tool: 2 – 3 weeks (training and practice to generate consistency in interpretation)
Application of the tool: 1 – 2 days (to process each medium to large sized protected area)

Further resources
Tool demonstration video:

Scientific paper describing tool by L. Bastin et al. 2013 Open-source mapping and services for Web-based land-cover validation. Ecological Informatics, 14: 9-16
http://ac.els-cdn.com/S1574954112001239/1-s2.0-S1574954112001239-main.pdf?_tid=815b724c-76e0-11e3-b41e-00000aabof26&acdnat=1389019416_f9cbae16556c18c024365bc103812371

Acknowledgements
This tool was developed by the Joint Research Committee (JRC) of the European Commission.
What is Terra-i?

Terra-i is an online tool that allows visualising land cover change in near real-time. It uses MODIS satellite imagery and algorithms 'trained' to recognise the normal pattern of changes in vegetation greenness in relation to terrain and rainfall for a site. The imagery is refreshed every 16 days at 250m resolution. Terra-i marks pixels as 'changed' where the greenness suddenly changes well beyond the normal limits. Coverage is currently limited to Latin America but will soon be extended to the entire tropics.

What can it be used for in the context of NBSAPs?

- Terra-i provides near real time change data and is useful for showing areas of ongoing habitat loss and disturbance, particularly areas undergoing deforestation in and around protected areas.
- Non-tropical vegetation.
- This product focuses on measuring change in a particular land cover class and is not intended to provide a definitive estimate of the extent of a land cover class.
- Terra-i can also show land cover change that is not related to changes in vegetation greenness or precipitation.

User Inputs

- Select area of interest.
- Select time period of interest (limited to 2004 onwards).
- Select output format (spatial data in raster format and associated statistics).

Outputs

- Detailed maps of land cover change with respect to baseline conditions of Normalised Difference Vegetation Index (NDVI)/precipitation but not thematic land cover change.
- Time series of areas of land cover change.
- Rates of change by country, administrative region, protected area and ecosystem.
**Strengths**
- Useful resolution for national and site-based analysis (250m).
- Online access from a web browser allows simple maps, statistics and reports to be produced without GIS or other software.
- Real-time updates available every 16 days as well as options to view annual data.
- Data available for numerous boundaries including national and protected area polygons.
- Data downloads available in GIS and CSV format and updated every two months. Tutorials available for using datasets and tool use.

**Weaknesses**
- Limited geographic coverage at present and only pan-tropical when fully operational.
- Change detection based on NDVI, i.e. not thematic land cover change.
- This system works on the assumption that a pattern of change in greenness (NDVI) and precipitation beyond normal bounds equates to a change in landcover.

**Time Requirements**
- Time required to learn to use: <1 day
- Time required to apply: ca. <1 day

**Further resources**
- Guide to visualising Terra-i data in ArcGIS software
  [http://www.terra-i.org/dms/docs/1_Visualization_ArcGIS_EN.pdf](http://www.terra-i.org/dms/docs/1_Visualization_ArcGIS_EN.pdf)
- Guide to downloading Terra-i data
- Guide to using the Terra-i statistics data tool data in ArcGIS software

**Acknowledgements**
Terra-i was developed collaboratively between the International Centre for Tropical Agriculture, The Nature Conservancy, HEIG-VD (Haute Ecole d’Ingenierie et de Gestion du Canton de Vaud) and King’s College London.
Dyna-CLUE

What is Dyna-CLUE?

Dyna-CLUE (the ‘Dynamic Conversion of Land Use and its Effects’ Model) is part of the CLUE model family, a group of land use and land cover change models. Dyna-CLUE has been specifically developed for the analysis of land use change in small regions (e.g. a watershed or province), at a fine spatial resolution. It allows the analysis and prediction of land use change in relation to socio-economic and biophysical driving factors. In a first step, the demand for land use is estimated outside the model based on an analysis of trends in land use or more advanced (economic) models. The model then creates a spatially explicit scenario of likely changes in land use through an allocation procedure19.

What can it be used for in the context of NBSAPs?

◆ Typical applications of the Dyna-CLUE model include: the simulation of deforestation; land degradation; urbanization and land abandonment; and the integrated assessment of land cover change. The model is especially useful for assessments of changes in complex spatial patterns of land use, as it is possible to simulate multiple land use types simultaneously.

◆ In the context of producing NBSAPs, Dyna-CLUE can be used to model the spatial impact of future scenarios on land use. This might include projected outcomes of conservation interventions in important areas for biodiversity, which can inform decision making and conservation strategies.

◆ The main focus of Dyna-CLUE is to analyze the impacts of different scenarios of land demand and land use policies on the spatial patterns of land use. It is not specifically designed to analyze the impacts of different policies on the size of land demand.

User Inputs

◆ Land use related data (land use requirements/demand). Settings related to types of land use conversion.

◆ Spatial data (spatial policies and restrictions) and location characteristics.

Outputs

◆ Calculation of the most likely future changes in land use through a spatial allocation procedure.


Strengths

◆ Open access software, downloadable online together with tutorials; may be used without restrictions for scientific purposes (but not for tendering).
◆ Flexible in terms of spatial extent, resolution, land use types, drivers and scenarios.
◆ Dynamically simulates competition between land use types, accounting for path-dependence (i.e. the impact of previous land use on future land use options) and bottom-up changes (i.e. changes that are determined by site conditions rather than by demand for land use).

Weaknesses

◆ The model requires an advanced insight into the characteristics of the land use systems in question.
◆ It requires advanced knowledge of GIS and modelling and is difficult to implement without prior experience in advanced spatial analysis.
◆ The user-interface of Dyna-CLUE only supports the spatial allocation of land use change, not the calculation of land demand.

Time Requirements

Time required to learn to use: 1 - 2 weeks
Time required to apply: < 1 week
Collection and preparation of input data: Up to several months, depending on data availability and desired quality of results

Further resources

CLUE Home Page
http://www.ivm.vu.nl/clue

CLUE Manual

Acknowledgements

Developed by the Institute for Environmental Studies, the original idea of the first CLUE model version was made by Tom Veldkamp and Louise Fresco and published in 1996. Later versions were created by Peter Verburg in collaboration with colleagues at Wageningen University and worldwide.

THE GLOBAL BIOSPHERE MANAGEMENT MODEL (GLOBIOM)

### Aichi Biodiversity Targets Tier

<table>
<thead>
<tr>
<th>Tier</th>
<th>Type of resource</th>
<th>Temporal considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Scale:** National to Global  **Access:** Restricted  **Language:** English

### What is the Global Biosphere Management Model (GLOBIOM)?

GLOBIOM is a global economic simulation model that has been developed to assess competition for land use between the main land-based production sectors: agriculture; bioenergy; and forestry. It is based on a recursively dynamic partial equilibrium model. The supply side is spatially explicit and takes into account land and weather characteristics. The market equilibrium is found by maximizing the sum of producer and consumer surplus subject to resource, technological, and political constraints.

GLOBIOM provides decision support for integrated land use planning across the three sectors in order to avoid serious land use conflicts and improve overall provision of food, forest fibre, and bio-fuels.

### What can it be used for in the context of NBSAPs?

- **GLOBIOM** identifies trends and drivers in future deforestation in various scenarios. It is a useful tool to identify possible trends in land demand from other sectors that conservation planning should take into account.

- **GLOBIOM** can simulate the shifting of land use from one place to another as a consequence of changes in economic drivers (displacement). If combined with spatial data on ecosystem services and biodiversity, GLOBIOM can also show where may be preferable to limit negative environmental and economic impact from land use change.

- Since GLOBIOM is a partial equilibrium model, the great detail in the representation of the agricultural and forest sectors is traded off for the missing link to other sectors in the economy.

### User Inputs

- Geospatial data (e.g. Soil, climate, topography).
- 5 forest products in 3 forest types.
- 18 crop types in 4 crop management systems.
- 6 livestock species in 8 livestock production systems.
- Socio-economic data.
- Geographically explicit production functions.
- Market demand functions.
- Trade tariffs.
- Transportation costs.

### Outputs

- Demand and supply quantities.
- Bilateral trade flows.
- Commodity prices.
- Resource prices.
- Land use maps.
- Deforestation and carbon emission trends.
- Impacts on ecosystems and biodiversity.
- Greenhouse Gas.
**Strengths**

- Can be used for forward-looking analysis of land use change and its impacts on ecosystem services and biodiversity for a number of baseline and future scenarios.
- Accounts for market and land use interrelationships and allows for dynamic feedback effects.
- Models crop, livestock and timber production in a spatially explicit way.
- High resolution output layers are available.
- Market equilibrium is determined based on economic benefits and on resource, technological and political constraints.

**Weaknesses**

- GLOBIOM is shared only within precisely defined collaborative projects.
- Application requires modelling experience.
- As for every model, GLOBIOM results depend on quality of input data.
- Model based on global, regional, and spatially explicit data.
- Data collection for country-level model calibration can be very time consuming.

**Time Requirements**

- Time required to learn to use: 3 – 6 months
- Time required to apply: 2 – 4 months
- Collection and preparation of input data: Up to several months, depending on data availability and desired quality of results

**Further resources**

Globiom homepage with background information and links to publications
http://www.globiom.org/

**Acknowledgements**

Globiom was developed by the International Institute for Applied Systems Analysis.
What is the Land Systems Map?

The Land Systems Map is a freely available global dataset showing current land systems at 5 arc-minutes (approximately 9.25km resolution). Land systems are representations of land use. This product aims to classify combinations of land cover composition, agricultural intensity and livestock density in a series of land systems, e.g. Cropland, intensive with pigs and poultry, or Grassland, with bovines, goat and sheep. These are especially useful for land-change modelling. This product was created from work by van Asselen and Verberg (2012) and builds on previous work but more explicitly includes intensity of agricultural land management and livestock density.

What can it be used for in the context of NBSAPs?

- Most current global scale land-use models use a classification of land cover based on the dominant land cover type within a distinct region or pixel. Such a classification disregards the diversity and intensity of human influence on land systems. Using Land Systems Maps in global models is expected to result in a more accurate representation of land use capturing important aspects of land systems and land architecture: the variation in land cover and the link between land-use intensity and livestock composition.

- This dataset could also be useful to illustrate current land use along with agricultural intensity, on a single categorical map. However, land use information may be available nationally or from the Food and Agriculture Organisation of the United Nations (FAO) (e.g. Land Use Systems of the World) that is appropriate for showing current land use.

User Inputs

- Download dataset – downloadable Raster data available online.
- Open dataset layer including legend within GIS software (e.g. ArcGIS/QGIS).
- Format layout and legend styles as required.

Outputs

- Map of land systems representing land use.


**Strengths**

- Useful for use in global land use modelling. Incorporates sub-pixel information on land cover, type and density of livestock and agricultural intensity to delineate land system.
- The global product is available in a consistent format and represents agricultural land, as well as natural vegetation mosaics.

**Weaknesses**

- Coarse resolution may be inappropriate for small countries.
- For regional scale modelling, realistic models require regionally specific determinants of land change.

**Time Requirements**

Time required to learn to use: <1 day (for simple thematic map creation)
Time required to apply: <1 day

**Further resources**

**Land Systems**

**FAO Land Use Systems of the World**

**Acknowledgements**

Land Systems Map was created from work by van Asselen and Verberg (2012) and builds on previous work but more explicitly includes intensity of agricultural land management and livestock diversity.
What is the World Database on Protected Areas (WDPA)?

The WDPA is the most comprehensive global dataset on terrestrial and marine protected areas. The WDPA started as the United Nations (UN) List of Protected Areas, produced under a mandate from the UN General Assembly since 1962, and developed into a spatial GIS mapping database on protected areas, including information on protected areas of all IUCN categories and governance types.

Today, governments and non-governmental organizations collect and submit information to the WDPA that maintains the accuracy of dataset. The WDPA maps all of the world’s protected areas and is available through a web-based portal www.protectedplanet.net that is powered by the WDPA.

What can it be used for in the context of NBSAPs?

The WDPA is a spatial database, through which maps of protected areas can be generated to identify the location of protected areas, both through viewing the data on the web viewer and through creating maps by manipulating the data in GIS software. Data can be categorised for display to identify different designation, governance and management types (through using the IUCN categories), for example.

- The WDPA data can also be used to report on progress on protected area coverage, analyse the biodiversity values protected areas cover, and to conduct gap and threat analyses of protected area systems, by undertaking overlay analyses with other GIS datasets.
- Due to variations in sources and resolution, if the data is viewed with, for example, Google Earth as a backdrop, slight discrepancies in boundaries, for example against coastlines, may be present.
- Moreover, the reported areas of the protected areas in the attribute table of the WDPA for a country cannot be added up to produce the total area protected, as many protected areas are actually overlapping. Instead a spatial analysis where overlapping protected areas are dissolved needs to be carried out to obtain an accurate coverage figure.
**User Inputs**

- Download dataset (shapefile format).
- Open dataset (open from within GIS software, zoom to area of interest).
- Edit for viewing (where required) e.g. select categories of interest, create buffers around point features or apply symbology.

**Outputs**

- Maps of protected areas for geographic region of interest.

**Strengths**

- Attribute and spatial information for more than 195,000 protected areas in 245 countries and territories (as of mid-2013).
- Only mandated global inventory of protected areas recognised by governments.
- Global data standards applied.

**Weaknesses**

- Where the boundary of a protected area is not available (polygon) a single latitude/longitude coordinate (point) location is stored instead, which gives a less accurate location and size for a protected area.
- National datasets may be more up to date.

**Time Requirements**

Time required to learn to use: <1 day
Time required to apply: ca. <1 day

**Further resources**

WDPA data viewer and download access
http://www.protectedplanet.net/

**Acknowledgements**

The WDPA is a joint product of IUCN and UNEP, managed by UNEP-WCMC.
What is the Global Biodiversity Information Facility (GBIF)?

GBIF was established by governments in 2001 to encourage free and open online access to biodiversity data. Through a global network of countries and organizations, GBIF promotes and facilitates the mobilization, access, discovery and use of information about the occurrence of organisms over time and across the planet. GBIF currently provides access to over 400 million indexed records of species occurrences from over 10,000 datasets.

What can it be used for in the context of NBSAPs?

◆ Understanding the precise locations at which species occur is useful for prioritising the actions needed to achieve Aichi Biodiversity Target 12.

◆ Such data, in combination with population counts and information on land-cover, land-use and land-management are used in the identification of KBAs, which may be targets for protected area expansion or establishment (and hence relevant to Aichi Biodiversity Target 11).

User Inputs

◆ Choose species or country of interest.

Outputs

◆ Maps showing compiled point localities for records of taxa at particular locations.
Strengths
◆ GBIF contains precise localities for species occurrences, and therefore does not suffer from the same potential commission errors (false presences) as polygon maps or presence/absence datasets.

Weaknesses
◆ The accuracy and precision of the underlying location data are variable.
◆ Point data suffer from sampling bias, with apparent distributions of species biased by the locations at which scientists have looked for them.
◆ GBIF acts as a portal for the contributed datasets, and the contributing sources are responsible for the data, hence the data quality is variable.
◆ Taxonomic inconsistencies and errors are incompletely resolved.

Time Requirements
Time required to learn to use: <1 day
Time required to apply: <1 day (For viewing/producing simple maps)

Any analysis may require refinement/manipulation of data prior to use and time requirements will depend on level of analysis.

Further resources
GBIF website homepage
http://www.gbif.org/

Acknowledgements
The GBIF is an international intergovernmental initiative, with its members as countries, economies and international organisations.
What is the IUCN Red List?

The IUCN Red List categorises species in terms of their risk of extinction, assigning them categories ranging from Least Concern to Extinct, with species in the categories of Critically Endangered, Endangered and Vulnerable collectively referred to as ‘threatened’. As well as a category, IUCN Red List assessments comprise information and data on: distribution; population; ecology; habitats; utilisation; threats; conservation actions in place and required; and a range of other factors. Assessments also include digital maps of the spatial distribution of species. Over 58,000 species have been assessed, and 43,000 species currently have digital distribution maps.

What can it be used for in the context of NBSAPs?

◆ The IUCN Red List provides information that is fundamental to achieving Aichi Biodiversity Target 12. The IUCN Red List is widely recognised as the most authoritative and objective system for identifying species at elevated risk of extinction. While many countries have national lists of species of concern, the IUCN Red List identifies species that are of global concern, and hence that will typically be among the highest priorities for conservation action within a country.

◆ More generally, information on the conservation status of species can also help to make a contribution to the achievement of many of the other Aichi targets. For example, it informs which are the aquatic species most at risk through unsustainable fishing (Aichi Biodiversity Target 6), which are the species most impacted by pollution or invasive alien species (Aichi Biodiversity Targets 8 and 9), and which are the sites that are most important to safeguard through protected areas (Aichi Biodiversity Target 11).

User Inputs

◆ Choose species of interest or search by other criteria such as location, threat category etc.

Outputs

◆ Digital distribution maps.

◆ Category of extinction risk for each species.

◆ Coded data on habitats, threats, actions and many other parameters.

◆ Text accounts providing an explanation of the status and reason for listing.
Strengths

◆ The IUCN Red List covers nearly all described species in several taxonomic groups (mammals, birds, amphibians, corals, conifers etc).

Weaknesses

◆ Data are incomplete for reptiles, fishes, invertebrates and plants.

◆ Digital distribution maps need to be interpreted carefully in spatial analyses to avoid ‘commission errors’ (false presences), because the maps are at a coarse resolution and polygons may contain many locations at a fine scale from which the species is absent.

Time Requirements

Time required to learn to use: <1 day
Time required to apply: <1 day

Further resources

IUCN spatial data
http://www.iucnredlist.org/technical-documents/spatial-data

Guidance on IUCN Red List Categories and Criteria
http://www.iucnredlist.org/technical-documents/red-list-documents

Guidelines on appropriate uses of Red List data

Bird spatial data
http://www.birdlife.org/datazone/info/spcdownload

Acknowledgements

The IUCN Red List was developed by the IUCN Species Programme working with the IUCN Species Survival Commission (SSC) and members of the IUCN Red List Partnership - including BirdLife International, Conservation International, Species Survival Commission, BGCI Plants for the Planet, NatureServe, Wildscreen, Texas A&M University and Microsoft – as well as contributing experts from universities, museums, research institutes and non-governmental organisations.
What are ‘Spatial projections for species distributions under climate change’?

Climate change will lead to shifts in the distributions of many species as a result of shifts in the distribution of suitable climatic conditions for them. ‘Species distribution models’ (also known as ‘climate envelope models’) can be used to project where species may potentially be distributed in future. BirdLife International and Durham University have used data from the Zoological Museum of the University of Copenhagen to create maps showing the potential distribution of all sub-Saharan African bird species for 2025, 2055 and 2085. These are viewable as graphics files online.

What can they be used for in the context of NBSAPs?

◆ Understanding how climate change may impact species and lead to shifts in their distribution is essential in order to ensure that “extinction of known threatened species has been prevented and their conservation status…improved” (Aichi Biodiversity Target 12).

◆ It is important for ensuring that “areas of importance for biodiversity…are conserved through effectively and equitably managed…protected areas…” (Aichi Biodiversity Target 11), as protected area networks will need to be designed, expanded, strengthened and effectively managed taking climate change impacts into account.

◆ Understanding impacts of climate change is fundamental if “the multiple anthropogenic pressures on coral reefs and other vulnerable ecosystems impacted by climate change…[are to be] minimized” (Aichi Biodiversity Target 10). By overlaying the maps of projected future potential distributions onto protected areas or KBAs, it is possible to examine potential ‘turn-over’ in species of concern within regions or in the locations of key sites.

User Inputs

◆ Choose bird species.

Outputs

◆ Maps of potential future distribution of species, and projected turnover of species at sites of concern (e.g. protected areas, KBAs).
**Strengths**

- Simple to interpret maps of projected species distribution changes.

**Weaknesses**

- Currently available only for birds, and for sub-Saharan Africa, but this will be expanded in due course for other regions.

**Time Requirements**

- Time required to learn to use: <1 day
- Time required to apply: <2 days

**Further resources**

- **The Africa Climate Exchange**
  http://www.africa-climate-exchange.org/

- **The Asia Climate Change toolkit**
  http://www.birdlife.org/asia-climate-change/


- **Scientific paper** by Hole et al. 2011 Towards a management framework for key biodiversity networks in the face of climatic change. *Conservation Biology* 25(2): 305-315

**Acknowledgements**

These models were produced by Durham University and BirdLife International with data provided by the Zoological Museum of the University of Copenhagen.
What is the Threatened Island Biodiversity Database?

Islands cover less than 5% of the Earth’s land area but represent the locations of 80% of known species extinctions since 1500, and support 39% of all surviving Critically Endangered species. Invasive alien vertebrates, such as cats, rats, goats and pigs, have been spread by people either deliberately or accidentally on many islands around the world. They are the primary cause of extinctions on islands and remain a critical threat to threatened island species today. Fortunately, techniques to protect island biodiversity through eradicating invasive vertebrates are now widely established. Over 1,000 successful such eradications have now been implemented worldwide, often followed by remarkable recoveries of endangered species and ecosystems.

The Threatened Island Biodiversity Database is a tool for governments and civil society to help prioritize conservation for threatened island biodiversity. It contains data on which threatened native vertebrate species occur on which specific islands and islets, and on which of these they are threatened by particular invasive alien vertebrates. It can therefore be used to help prioritize islands—locally, nationally, regionally or globally—in terms of the feasibility and cost of implementing eradications compared with the potential biodiversity benefits. The database currently contains data on nearly 2,000 islands for 1,182 threatened species, collated from 1,800 scientific literature sources and the contribution of almost 400 experts. The database has been developed by Island Conservation, the University of California at Santa Cruz Coastal Conservation Action Laboratory, BirdLife International, and the IUCN Invasive Species Specialist Group.

What can it be used for in the context of NBSAPs?

« The Threatened Island Biodiversity Database can help prioritize eradication of invasive vertebrates on islands to benefit native species of conservation concern. It is invaluable for achieving Aichi Biodiversity Target 9, under which “invasive alien species...are identified and prioritised, and priority species are controlled or eradicated”.

« Given the significance of the negative impacts that invasive alien species have on threatened native species, the database can also play a useful role in helping governments to achieve Aichi Biodiversity Target 12, under which “extinction of known threatened species has been prevented and their conservation status...improved”.

« It can also inform the measures necessary for effective management of protected areas (Aichi Biodiversity Target 11).
**User Inputs**
◆ Choose species (either threatened or invasive or choose by geographic location).

**Outputs**
◆ Spatial and tabular data for each island on the threatened native vertebrates and invasive alien species occurring on it.

**Strengths**
◆ Simple to use.
◆ Ability to interrogate data by drawing polygons.

**Weaknesses**
◆ The Threatened Island Biodiversity Database is currently restricted to vertebrates (data on native and invasive invertebrates and plants are missing). It is also largely restricted to those species assessed as threatened on the IUCN Red List (www.iucnredlist.org); therefore data are not comprehensive for reptiles.

**Time Requirements**
Time required to learn to use: <1 day
Time required to apply: <1 day

**Further resources**

**Detailed factsheets** for all bird species, including information on threats from invasive alien species
www.birdlife.org/datazone/species

**Global Island Database** (spatial data on over 400,000 islands around the world)
http://gid.unep-wcmc.org/

**Global Invasive Species Database**, including factsheets on invasive alien species
http://www.issg.org/database/welcome/

**Acknowledgements**
The Threatened Island Biodiversity Database was developed by Island Conservation, University of California Santa Cruz Coastal Conservation Action Lab, BirdLife International, IUCN Invasive Species Specialist Group and UNEP-WCMC.
MARXAN

What is Marxan?

Marxan is decision-support software that was originally developed for designing a cost-efficient protected area network based on a set of user defined criteria and cost data. Marxan can also be applied to a wide range of other land use planning exercises, and could be used in NBSAP processes at national level.

What can it be used for in the context of NBSAPs?

- Marxan enables analysis of quantitative spatial data to identify sets of planning units that meet user-defined targets for attributes like biodiversity or ecosystem service provision, at minimal cost and trade-offs with other targets. Targets can be set for biological, economic and social parameters.
- Marxan with zones, an extension of Marxan, provides a more comprehensive analysis allowing different management strategies to be prioritized for different land use zones.
- Marxan does not provide ‘final answers’, rather it provides a range of ‘good’ solutions to support decision making.
- It does not allow consideration of several possible land management strategies at the same time, i.e. Marxan cannot set different strategies for different land use zones (but Marxan with zones can).
- It does not help identify targets, the user must define them.

User Inputs

- Stakeholder input - user defined targets and costs
- GIS data – target-related datasets (e.g. species distributions, ecosystem services distribution).

Outputs

- Priority areas (e.g. for including in a protected area network) based on user-defined targets.
- Total cost for priority areas; cost is user-defined but could be opportunity cost, implementation cost or area depending on data availability.
**Strengths**

◆ Very flexible programme, widely used for multiple purposes, good documentation and user support.
◆ Open access software, downloadable online, compatible with open source GIS software.
◆ Areas selected as optimal outputs are constrained by user-defined cost.
◆ Both development and conservation targets can be considered simultaneously in one land use planning exercise.

**Weaknesses**

◆ The process whereby the output areas are selected may not be easy to follow.
◆ GIS expertise required.
◆ Lots of time needed to both produce and consult on inputs and outputs.

**Time Requirements**

Time required to learn to use: <1 day
Time required to apply: ca. <1 day

**Further resources**

**Marxan Online Tutorial**

**Key Marxan References List**

**Marxan with zones**

**Marxan good practice guidance**

**Acknowledgements**

The Marxan software is hosted by The University of Queensland and The Australian Government Antarctic Division.


Marxan with Zones: