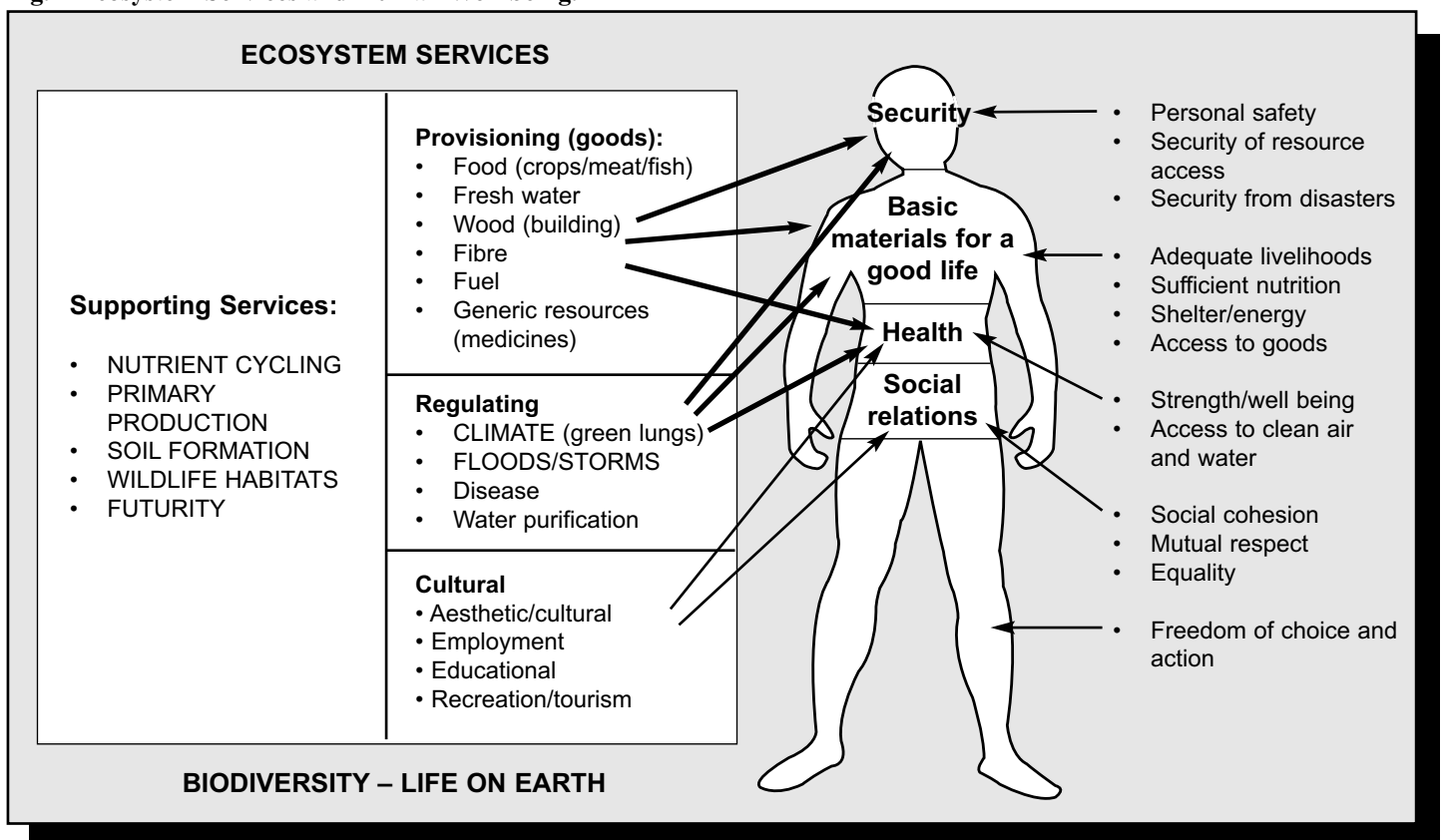# Millennium Ecosystem Assessment 1
# BIODIVERSITY LOSS

**Introducing the Challenge**

This *Factsheet* looks at what the Millennium Ecosystem (MA) found about the state of the World's Ecosystems. As *Fig. 1* shows, all the World's people depend on the Earth's ecosystems, and the good and services they provide for their well-being and ultimate survival.

**Fig. 1 Ecosystem Services and Human Well-being.**



**ECOSYSTEM SERVICES**

**Supporting Services:**
- NUTRIENT CYCLING
- PRIMARY PRODUCTION
- SOIL FORMATION
- WILDLIFE HABITATS
- FUTURITY

**Provisioning (goods):**
- Food (crops/meat/fish)
- Fresh water
- Wood (building)
- Fibre
- Fuel
- Generic resources (medicines)

**Regulating**
- CLIMATE (green lungs)
- FLOODS/STORMS
- Disease
- Water purification

**Cultural**
- Aesthetic/cultural
- Employment
- Educational
- Recreation/tourism

**Security**
- Personal safety
- Security of resource access
- Security from disasters

**Basic materials for a good life**
- Adequate livelihoods
- Sufficient nutrition
- Shelter/energy
- Access to goods

**Health**
- Strength/well being
- Access to clean air and water

**Social relations**
- Social cohesion
- Mutual respect
- Equality

- Freedom of choice and action

**BIODIVERSITY – LIFE ON EARTH**

The challenge is that if we degrade the ecosystems for short term provision of goods, long term we will lose the valuable services needed for human well-being as well as supporting services for ecosystem survival.

It is very difficult to put a **quantitative** value on these vital services, but it has been suggested that the most valuable of all the functions were (in rank order) soil formation, nutrient cycling, climate regulation, provision of wildlife habitats, aesthetic enjoyment and recreation and water/flood regulation. Yet for too long, and at an accelerating pace in both rich and poor nations, development priorities have focused on how much people, businesses and government can take from ecosystems.

In response to this challenge, the UN Secretary General instituted the Millennium Ecosystem Assessment (MA) in 2001. Under the co-ordination of the United Nation Environmental Programme (UNEP) an enormous range of assessments was conducted. The MA was a **multi-scale** assessment across 13 major ecosystems (terrestrial, freshwater and marine) using standardised methodology at a range of scales from local to global.

The work took 5 years to complete, and involved 1360 experts from 95 countries. It was guided by a Board representing UN agencies, International Scientific Organisations and agencies, governments, business, NGOs and indigenous people.

What is of particular significance is:
(1) the sheer **scale** of the exercise as hitherto only smaller scale surveys such as WWF's **Living Planet Index** has been used to assess the state of the world's ecosystems, *and*
(2) the efforts made to discuss, verify and validate the findings before publication.

The MA identified three major issues associated with our management of ecosystems:

1 As more effective methods of aerial survey and satellite surveillance develop, the extent and severity of ecosystem destruction and the impact of degradation which leads to eco stress and the deterioration of ecosystem quality becomes more apparent and can be monitored over time (e.g. the destruction of the Amazon rainforest for soy bean cultivation, or the result of over use of fertilisers leading to algal blooming). This shows us that people have changed ecosystems more rapidly and more extensively than in any comparable period of time in human history. Paradoxically, rising population combined with an increasing ability to pay for provisioning services (goods) to improve human well being, has led to **unsustainable** demands on ecosystems, not only at the expense of future generations (e.g. gene pool), but also at the expense of other aspects of well being *(see Fig. 1)*.

2 Ecosystem degradation, which reduces their capacity to deliver regulatory and cultural services, is borne disproportionately by the world's poor who are concentrated in Sub-Saharan Africa. Rural people who are a primary target for the Millennium Development Goals (MDG), tend to be most directly reliant on ecosystem services for subsistence and most vulnerable to changes leading to widespread hunger, famine and increasing poverty.

3 There is also evidence to suggest that **biodiversity** ('the genetic variability amongst living organisms') loss can lead to accelerating, abrupt and potentially irreversible changes at a species and habitat level (e.g. the impact of entrophication and hypoxia, once a threshold nutrient load is reached, with algal blooms frequently leading to the formation of oxygen depleted waters, killing most forms of life (i.e. dead zones in coastal waters or lakes).

Without complex **ex-situ** conservation, e.g. in zoos, rare and endemic species can be lost for ever, and habitats can deteriorate beyond the tipping point.

**Fig. 2 Snapshot of MA findings.**

### Habitats
- More land was converted to crop land 1950 - 1980 than in the 150 years between 1700 and 1850. 25% of the earth's surface is now cultivated.

### Agro-ecosystems
- Major areas of land degradation occurred in the world's dry lands as a result *(see Fig. 2a)*.
- Major areas of forest loss occurred especially in **tropical rainforest** areas but these were counterbalanced in quantity (not quality) by many areas of **net forest gain** (Scandinavia/SE USA).
- Approximately 20% of the world's coral reefs were lost with an additional 20% showing severe degradation (from physical and human causes).
- 35% of the world's mangroves were lost largely to coastal development.
- The amount of water impounded by **mega dams** has quadrupled since 1960 so that about five times as much water is held in reservoirs as opposed to normal rivers.
- Water withdrawal from lakes and rivers has doubled since 1960 with many areas in severe deficit, e.g. SW USA.
- Since 1960 flows of reactive nitrogen in terrestrial ecosystems have doubled and those for phosphorus have tripled (major consequences for fresh water ecosystems).
- Since 1750 atmospheric concentrations of $CO_2$ have increased by a third – 60% of this since 1960.

**Fig. 2a**

Fraction of potential area converted



Key:
- Loss by 1950
- Loss 1950 - 90
- Projected loss by 2050 (black line represents margin of error)

**Fig. 2b**



### Species
- Across a range of taxonomic groups either their population size or range or both are declining.
- 10-30% of mammal, bird, and amphibian species are currently threatened with extinction, i.e. on the **Red List**.
- The number of all species on the planet is declining (with freshwater systems the most threatened) at an increased rate *(see Fig. 2b)*.
- Genetic diversity has declined globally especially among cultivated species.
- The distribution of species is becoming more homogeneous and less endemic as a result of global interconnections.
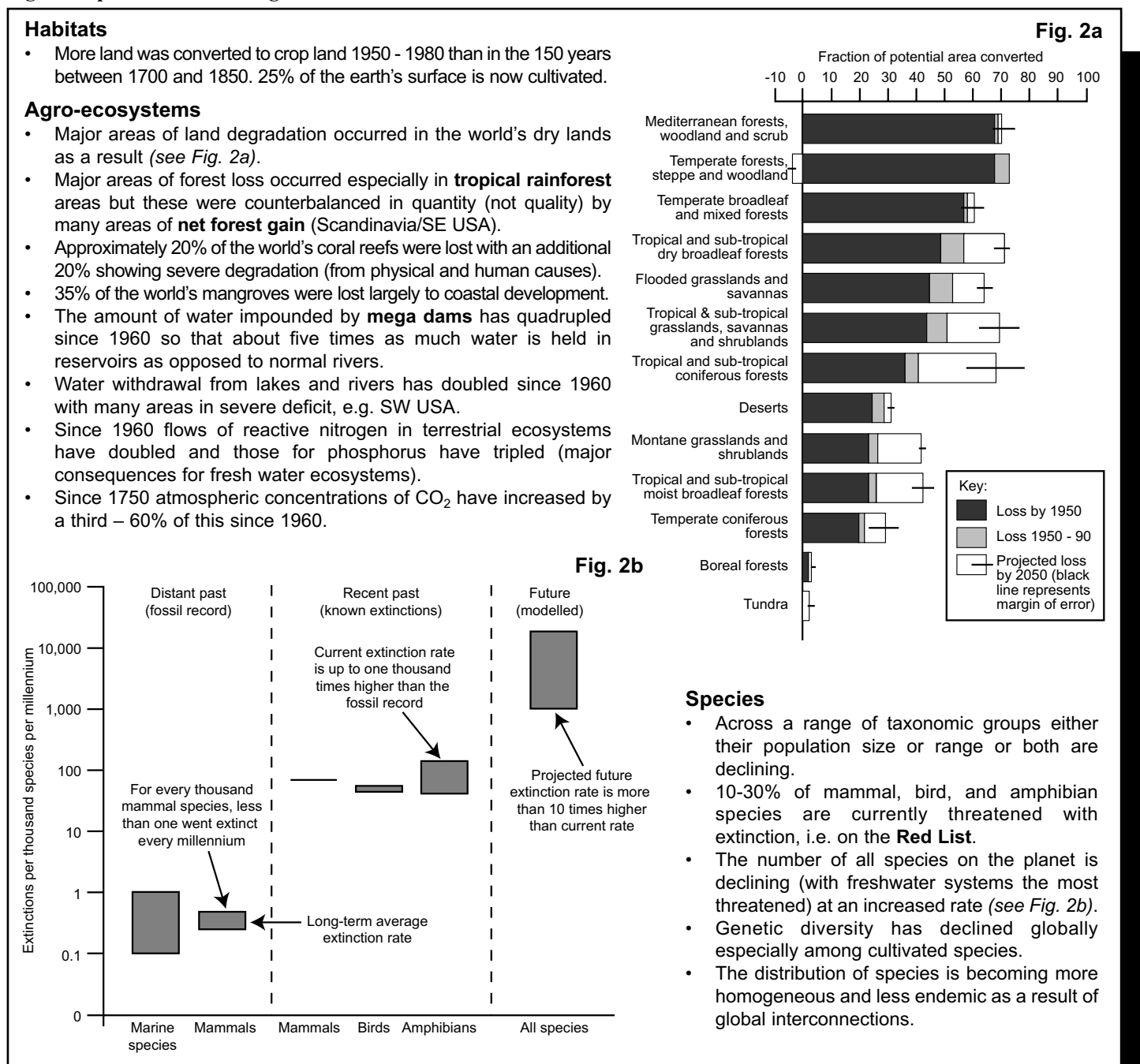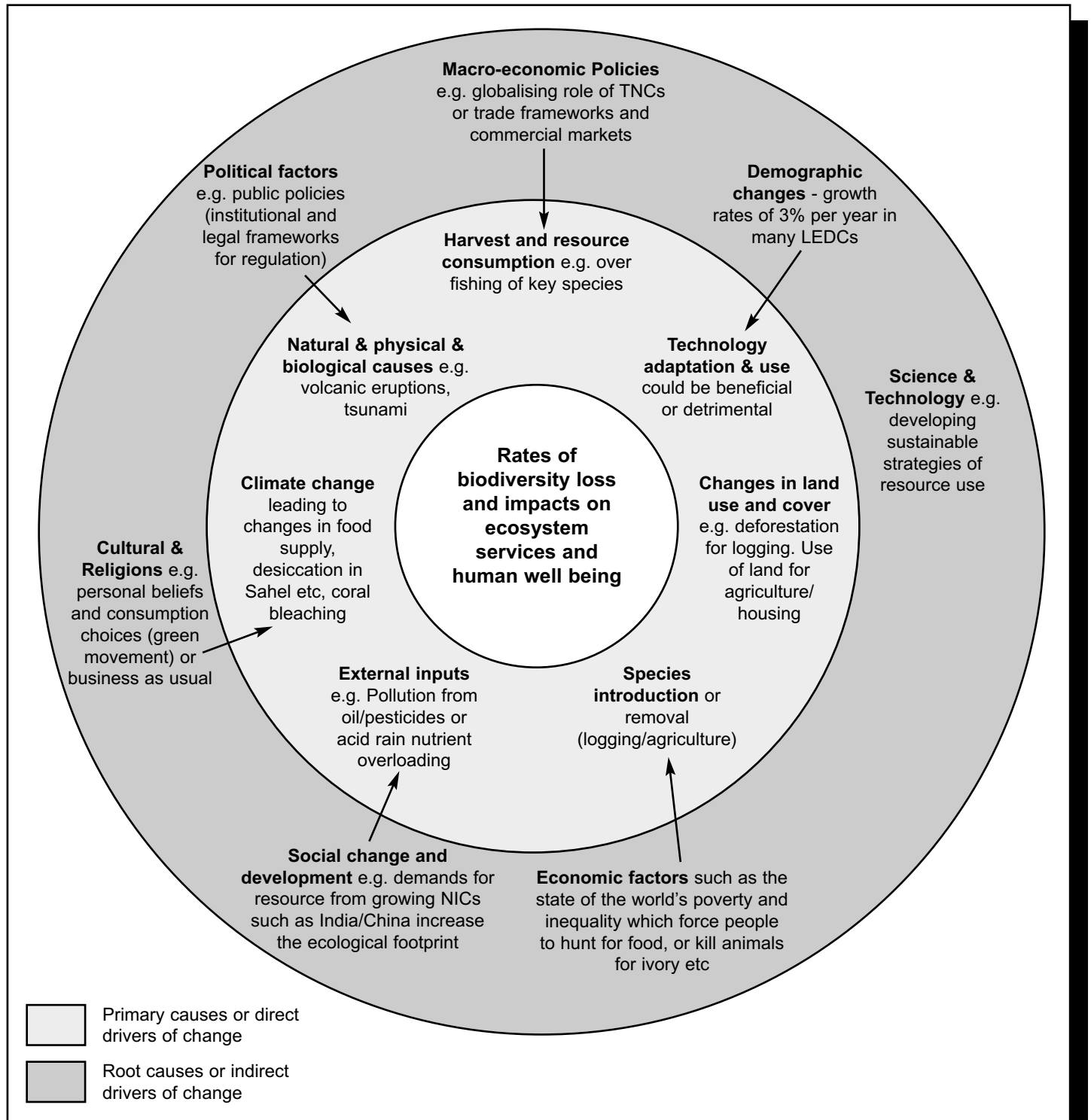
*Fig. 3* summarises the reasons for ecosystems change which vary considerably from place to place. In general these factors lead to negative changes and biodiversity loss, but increasingly conservation strategies are in place to lead to positive changes. The factors responsible are known as **drivers of change**. You can use your own case studies to explore the causes of ecosystem change.
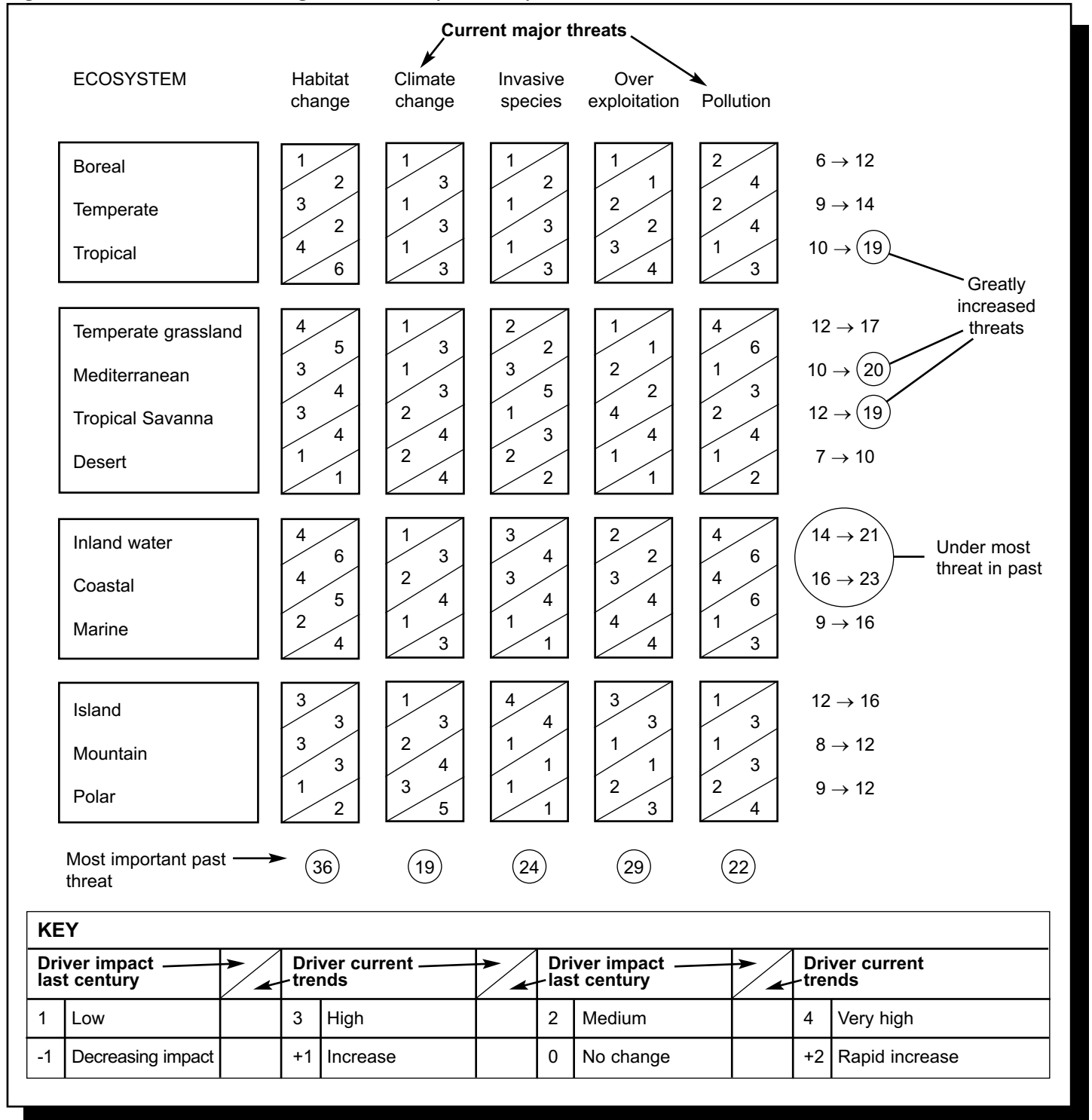
**Fig. 3 The Drivers of Ecosystems Change.**



**Macro-economic Policies** e.g. globalising role of TNCs or trade frameworks and commercial markets

**Political factors** e.g. public policies (institutional and legal frameworks for regulation)

**Demographic changes** - growth rates of 3% per year in many LEDCs

**Harvest and resource consumption** e.g. over fishing of key species

**Natural & physical & biological causes** e.g. volcanic eruptions, tsunami

**Technology adaptation & use** could be beneficial or detrimental

**Science & Technology** e.g. developing sustainable strategies of resource use

**Rates of biodiversity loss and impacts on ecosystem services and human well being**

**Climate change** leading to changes in food supply, desiccation in Sahel etc, coral bleaching

**Changes in land use and cover** e.g. deforestation for logging. Use of land for agriculture/ housing

**Cultural & Religions** e.g. personal beliefs and consumption choices (green movement) or business as usual

**External inputs** e.g. Pollution from oil/pesticides or acid rain nutrient overloading

**Species introduction** or removal (logging/agriculture)

**Social change and development** e.g. demands for resource from growing NICs such as India/China increase the ecological footprint

**Economic factors** such as the state of the world's poverty and inequality which force people to hunt for food, or kill animals for ivory etc

Primary causes or direct drivers of change

Root causes or indirect drivers of change

**Exam Hint:** *Using the Framework - Take your own examples and use Fig. 3 as a framework to assess the balance of causes.*

*e.g. In the **Udzungwa Forest** in Tanzania: the direct drivers are the rates of harvesting of the forest and the changes of land use. The root causes are pressures from over population and poverty which lead to demands for fuel wood, and meat from forest animals. The driving force for conservation comes from the Government which provides a legal framework for National Park creation, and sustainable development of SCIP projects and eco-tourism thus raising poverty levels of local people.*

## Causes of Biodiversity Loss

*Fig. 4* shows the impact of these drivers on the 13 ecosystems. As you can see, it is again a very variable picture, but in general one of biodiversity loss.

**Fig. 4 Main direct drivers of change in biodiversity and ecosystems.**

**Current major threats**

| ECOSYSTEM | Habitat change | Climate change | Invasive species | Over exploitation | Pollution | Past → Current |
|---|---|---|---|---|---|---|
| Boreal | 1 / 2 | 1 / 3 | 1 / 2 | 1 / 1 | 2 / 4 | 6 → 12 |
| Temperate | 3 / 2 | 1 / 3 | 1 / 3 | 2 / 2 | 2 / 4 | 9 → 14 |
| Tropical | 4 / 6 | 1 / 3 | 1 / 3 | 3 / 4 | 1 / 3 | 10 → (19) |
| Temperate grassland | 4 / 5 | 1 / 3 | 2 / 2 | 1 / 1 | 4 / 6 | 12 → 17 |
| Mediterranean | 3 / 4 | 1 / 3 | 3 / 5 | 2 / 2 | 1 / 3 | 10 → (20) |
| Tropical Savanna | 3 / 4 | 2 / 4 | 1 / 3 | 4 / 4 | 2 / 4 | 12 → (19) |
| Desert | 1 / 1 | 2 / 4 | 2 / 2 | 1 / 1 | 1 / 2 | 7 → 10 |
| Inland water | 4 / 6 | 1 / 3 | 3 / 4 | 2 / 2 | 4 / 6 | 14 → 21 |
| Coastal | 4 / 5 | 2 / 4 | 3 / 4 | 3 / 4 | 4 / 6 | 16 → 23 |
| Marine | 2 / 4 | 1 / 3 | 1 / 1 | 4 / 4 | 1 / 3 | 9 → 16 |
| Island | 3 / 3 | 1 / 3 | 4 / 4 | 3 / 3 | 1 / 3 | 12 → 16 |
| Mountain | 3 / 3 | 2 / 4 | 1 / 1 | 1 / 1 | 1 / 3 | 8 → 12 |
| Polar | 1 / 2 | 3 / 5 | 1 / 1 | 2 / 3 | 2 / 4 | 9 → 12 |
| **Most important past threat →** | (36) | (19) | (24) | (29) | (22) | |

Greatly increased threats → 10 → (19), 10 → (20), 12 → (19)

Under most threat in past → 14 → 21, 16 → 23

| KEY | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Driver impact last century** → ⟋ ← **Driver current trends** | | **Driver impact last century** → ⟋ ← **Driver current trends** | | | | | |
| 1 | Low | 3 | High | 2 | Medium | 4 | Very high |
| -1 | Decreasing impact | +1 | Increase | 0 | No change | +2 | Rapid increase |

**Exam Hint:** *Matrices of this kind are frequently produced by World Resources Institute (WRI). You need to learn the techniques of analysis:*
*(1) Analyse the past threats by factor and ecosystem.*
*(2) Analyse the current threats by factor and ecosystem – note all seem to be getting worse – especially pollution, and especially dry land ecosystems, with the one exception of habitat change in temperate forest (new tree planting).*
*(3) Look at each ecosystem individually – e.g. island ecosystems were under extreme threat from invading species, but this situation is getting no worse, where as pollution and climate change are – e.g. Galapagos.*

Not surprisingly, the projected ecosystem changes will have a major impact on human well being. As *Table 1* shows, whilst food security continues to improve globally, the unsustainable use of ecosystems for their provisioning services (goods) has an inevitable impact on other services such as regulating/supporting services and some improvements such as agriculture are themselves environmentally damaging.

**Table 1 Trends in the use of ecosystem services evaluated in MA.**

| Services | Subcategory | Status | Notes |
|---|---|---|---|
| **Provisioning Services** i.e. goods | Crops | ▲ | Food provision globally has grown faster than population growth because of intensification but also extension of cropland/grazing onto dry lands often with damaging environmental impacts such as soil erosion. |
| | Livestock | ▲ | |
| Food | Commercial fishing | ▼ | Major problems of over fishing in marine and freshwater areas. Demand still increasing especially in Far East puts pressure on all fishing areas. |
| | Aqua culture | ▲ | Has become a globally significant source of food (27% of all production), but many environmental concerns such as disease and food for feeding farmed fish. |
| Fibre | Timber | +/- | Global timer production increasing but often from plantations, although still great pressure on valuable hardwoods of rain forest. |
| | Natural fibres e.g. cotton | +/- | Some increased production especially of organic cotton Jute declined. |
| | Fuel wood use | ▼ | A major problem – a threat in nearly all LDCs in spite of new efficient stoves, solar power and mini hydros. |
| Genetic resources | Crops | ▼ | Many potential sources form the gene pool lost. Mono cultural farming has decreased genetic diversity. |
| | Medicines | ▼ | |
| Fresh Water | Water quantity | ▼ | In up to 25% of areas global freshwater use exceeds supplies (impact of growing population, irrigation use etc). |
| | Water quality | ▼ | Issues of pollution in many water systems. |
| **Regulating services** | Air quality | ▼ | Slight decline. Improvements in MEDCs, impact of NICs – Asian Brown Cloud etc. |
| | Climate regulation | ▼ | Responses of negative impacts as forests are destroyed, also desertification. |
| | Water regulation | +/- | Major impact of forest removal on water sheds → increased flooding and soil erosion, but some replanting/ catchment management. |
| | Erosion regulation | ▼ | |
| | Water purification waste | ▼ | Globally water quality is declining especially therefore of fertilisers and pesticides. |
| | Pest regulation | ▼ | Some increase in disease of ecosystem modification. |
| | Natural hazard regulation | ▼ | Removal of forests/mangroves exacerbates impact of extreme events e.g. tsunamis. |
| **Cultural services** | Spiritual & religious values | ▼ | A number of sacred sites have been lost. |
| | Recreation and tourism | +/- | Demand is increasing and areas such as coral reefs are degraded, but increasingly new green eco-tourism is being developed. |
| | Aesthetic values | ▼ | Greater urbanisation places pressure on these areas e.g. pressure on green belt land. |

Key:   ▲ = Improvements        +/- = Some improvement, some decline        ▼ = Decline

*Note: as ecosystems are destroyed and degraded the potential for these services would decrease.*

In conclusion this *Factsheet* shows that MA identifies the state of the World's ecosystems as a major cause for concern as changes are leading to biodiversity loss. As a following *Factsheet* will explore, so much depends on what options for development and conservation of ecosystems are chosen.

**Further Reading and Research**
- *Ecosystems and Human Well Being* – Synthesis of MA Island Press ISBN 1-59726-040-1
- *Living Planet Atlas* – published annually by WWF
- *Atlas of Endangered Species, Earth Scan*

**Useful Websites**
- *www.wri.org*  World Resource Institute
- *www.unep.org*  United Nations Environmental Programme
- *www.mea.org*  Millennium Ecosystems Assessment
- *www.wwf.org.uk* or *www.panda.org*  WWF sites