

Topic 1: ecosystems at risk

[Environment](#), [Ecology](#)



Topic 1: Ecosystems at Risk A. Ecosystems and Their Management 2.

Vulnerability and Resilience of Ecosystems * Vulnerability is the sensitivity of an ecosystem to cope with stress. * Resilience is the ability of an ecosystem (or a component of an ecosystem) to adapt to a changing environment and to restore function and structure following an episode of natural or human-induced stress. * All ecosystems function in a state of dynamic equilibrium or a continual state of balanced change. * This state of dynamic equilibrium is the product of the interrelationship of the elements in the ecosystem: the atmosphere, lithosphere, hydrosphere and biosphere. * Change occurs because the interrelationship between minerals, energy and communities varies over time. * It is also the interdependence of these four elements that makes an ecosystem vulnerable. * A change beyond the limits of the equilibrium, in any of these elements, means that the system as a whole cannot exist in its original state. * All ecosystems are, in a sense, vulnerable, but the level of vulnerability depends on how small a change is needed in any element to upset the equilibrium. * Ecosystems, are therefore, not equally at risk — some are more resilient than others. Which ecosystems have greater resilience? Resilience is the ability of an ecosystem (or component of an ecosystem) to adapt to a changing environment and to restore function and structure following an episode of natural or human-induced stress. Ecosystems rich in biodiversity generally have greater resilience than those with little diversity. They are able to recover more readily from naturally induced stress (including drought and fire) and human-induced habitat destruction. 2. Under what conditions does long-term degradation occur? Long-term degeneration occurs when the magnitude and

duration of the stress exceed the ability of the component to repair itself. 3. Explain the process shown in Fig 1. 1. 28. Figure 1. 1. 28 shows the impact of stress on the functioning of ecosystems. It shows the Elasticity and the rate of recovery of an ecosystem property following disturbance. It also shows the rate of amplitude and the threshold level of strain beyond. The intensity and duration of stress is important in terms of the effect it has on ecosystems. 4. Outline how natural sources of stress can play an important role in the functioning of ecosystems. These changes could be in response to changes in the availability of water, average temperature or many other natural events. In nature, these changes usually take place very slowly. The biome gradually adapts as animals and plant species that have characteristics unsuited to the change die out and those more suited the environment remains alive to breed and pass on their characteristics to successive generations. This process is known as natural selection. Causes of Ecosystem Vulnerability * All ecosystems have some ability to withstand stress. * They tend to resist being disturbed or altered and will restore themselves to their original condition if not disturbed too dramatically. * In other words, ecosystems maintain themselves within a tolerable range of conditions. * A number of factors are relevant to the vulnerability of ecosystems to stress, including location, extent, biodiversity and linkages. a) Location * Where an ecosystem is will affect its functioning. * At a global scale, latitude, distance from the sea, and altitude play decisive roles in determining climate and ultimately the nature of particular ecosystems. * The microclimatic features of a location can be significant enough to create a range of distinctive ecosystem types within relatively small areas e. g. aspect. * Some

ecosystems are located in environments that are extreme e. g. deserts, polar, hypersaline lagoons. * Organisms capable of living in such conditions are highly specialised. * The greater the degree of specialisation of an organism to a particular set of environmental conditions the more vulnerable it is to changes in those conditions e. g. coral * Corals are highly specialised organisms that flourish in the relatively shallow, nutrient-deficient waters of the tropics. - * Any increase in nutrient levels promotes the growth of algae, which reduces the amount of sunlight available for coral growth. * If high nutrient levels continue the corals become stressed, reefs contract in size and the number of coral species declines. * Coral is also sensitive to changes in water temperature, and flourish between 25°C to 29°C. * A small increase in the temperature can kill the coral polyp, leaving only the white calcium skeleton (coral bleaching). * Proximity to large concentrations of people is another important contributing factor to ecosystem vulnerability; demand for land grows as populations grow. * Urban, industrial and agricultural land uses destroy natural ecosystems, while oceans, rivers and the atmosphere become dumping grounds for pollutants. b) Extent The extent (size) of any particular ecosystem is the product of a variety of factors. - Recent research has shown that the boundaries of ecosystems tend to overlap each other. - E. g. river ecosystems extended beyond the river channel to include the whole drainage system. - Thus, human activity in the drainage basin can impact on the river itself even when it occurs some distance from the channel. - E. g. may increase soil erosion - A study showed that stoneflies and other creatures living in shallow wells on the flood plain of the river, up to 2km away from the river, mated along the riverbanks before returning to

lay their eggs in the wells. - This means the floodplain and the river cannot be considered as separate systems. - Ecosystems that are restricted to relatively small areas or have already been distributed extensively are especially vulnerable - Tropical rainforest, have relatively small populations of a large number of species confined to relatively small, localised communities - Loss of small areas of rainforest can lead to extinction of plant and animal species - Savanna grasslands, have large populations of a small number of species spread out over much larger areas - Loss of a small area of grassland therefore need not result in the extinction of species. - Large herbivores typical of these regions require extensive grazing areas - c)

Biodiversity Biodiversity is usually considered at three levels: genetic diversity, species diversity and ecosystem diversity. i) Genetic diversity - Genetic diversity is the variety of genetic information contained in all the individual plants, animals and micro-organisms - Genetic diversity occurs within and between populations of species as well as between species. - Genetic diversity favours the survival of a species, because it increases the chance that some members of the species will have characteristics that aid their survival - Often a gene has costs as well as benefits - A study has shown that peach potato aphids that are resistant to common pesticides are less able to survive - ii) Species diversity - Species diversity is a measure of the number of species at each trophic level of an ecosystem - The greater the species diversity the more robust the ecosystem - If the population of one consumer organism crashes there are other producers available that can fulfil a similar function in the ecosystem - When ecosystems are diverse, there is a range of pathways for the ecological processes, such as nutrient

recycling - If one pathway is damaged or destroyed, an alternative may be used and the ecosystem can continue to function at its normal level - If the level of biodiversity is greatly diminished, the functioning of the ecosystem is put at risk - The greater the level of diversity, the greater the opportunity to adapt to change - Many diverse ecosystems are characterised by highly specialised organisms - A species may be vulnerable even if the ecosystem as a whole is not - iii) Ecosystem diversity - Ecosystem diversity refers to the diversity present within ecosystems in terms of habitat differences, biotic communities and the variety of ecological processes d) Linkages -

Interdependence, or linkages, is related to species diversity - The greater the level of interdependence within an ecosystem the greater its ability to absorb change - The loss of a primary consumer from a food web, e. g. is unlikely to have a major impact on secondary consumers if there is a range of alternative primary consumers on which to feed - Ecosystems that have low levels of interdependence are much more vulnerable to change - Krill are the dominant primary consumer organism and the main source of energy for some species of whale - Interdependence can take very subtle forms e. g. some flowering plants can be fertilised by only one species of insect - Anything that jeopardises this third organism, therefore, will affect the reproductive success of the flowering plant - Primary consumers have highly specific food sources, and many parasitic organisms depend on specific hosts - The same characteristics can be exploited by humans in the biological control of pest species - Large consumer animals may range across a number of small, localised ecosystems, having genetically adapted to the variations in all of them - 1. Outline (using examples) how the level of

interdependence within an ecosystem will affect its vulnerability.

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Interdependence can take very subtle forms e. g. some flowering plants can be fertilised by only one species of insect. This insect may turn, be dependent on some other organism for part of its life cycle. Case study:

Vulnerability of Minnamurra Rainforest The Minnamurra rainforest is a small pocket of rainforest located on the South Coast of New South Wales near Kiama. The extent, biodiversity and location of the rainforest all work together to make this a vulnerable ecosystem. It is located close to urban development and is surrounded by farms. This increases the levels of pollutants entering the system and has lead to significant weed infestation.

Natural and Human-Induced Environmental Stress * Ecosystems are constantly changing and evolving in response to stress-induced changes within the total environment. * These changes may be brought about naturally e. g. drought, or may be human-induced e. g. deforestation. *

Natural changes usually take place more slowly than human-induced changes and the biome gradually adapts as animals and plant species that have characteristics unsuited to the change die out, and those more suited to the new environment remain alive to breed and pass on their

characteristics to successive generations (a process known as natural selection). * Sudden natural disasters have occurred from time to time which have caused whole species to die out almost instantly because they had no time to adapt, however this is rare. * In contrast, human-induced changes are usually rapid and do not allow species to adapt. * The ability to instigate large-scale environmental change means that people are able to push the state of dynamic equilibrium beyond its limits. * This means that people have created situations where they are required to maintain a state of equilibrium by utilising resources found elsewhere e. g. the use of fertilisers and pesticides to maintain an agricultural monoculture, which would collapse without them. * Today, human activities destroy or seriously threaten species and destroy or degrade their habitat. Changes affecting ecosystems by cause and rate | | Catastrophic | Gradual | | Natural sources of environmental stress | Drought | Climatic Change | | | Flood | Immigration of new species | | | Fire | Adaptation/evolution | | | Volcanic eruption | Ecological succession | | | Earth Quake | disease | | | Landslide | | | Change in stream course | | | Disease | | | Human-induced sources of environmental stress | Deforestation | Irrigation- salinization, waterlogging | | | Overgrazing | Soil compaction | | | Ploughing | Depletion of ground water | | | Erosion | Water/air pollution | | | Pesticide application | Loss and degradation of wildlife activity | | | Fire | Elimination of pests and predators | | | Mining | Introduction of new species | | | Toxic Contamination | Overhunting/Overfishing | | | Urbanisation | Toxic contamination | | | Water/Air pollution | Urbanisation | | | Loss and degradation of wildlife activity | Excessive tourism | a) Natural environmental stress * Some natural sources of stress can be catastrophic and cause very

rapid change e. g. droughts, floods, fire, volcanic eruptions, earthquakes, landslides, disease, tsunamis and cyclones. * Most natural sources of environmental stress are more gradual and do allow species to adapt e. g. climatic change, immigration, adaption/evolution, ecological succession, disease, geographical isolation. * Climate change was thought to be the reason behind the extinction of the dinosaur. * Ecological succession involves one species gradually taking over an environment from another as circumstances within the environment change e. g. as a climate becomes drier, drought-resistant species will gradually take over. Some of the effects of environmental stress

Organism Level
 Physiological and biological changes
 Psychological disorders
 Behavioural changes
 Fewer or no offspring
 Genetic defects in offspring
 Cancers

Population Level
 Population increase or decrease
 Change in age structure
 Survival of different genetic strains based on stress threshold
 Loss of genetic diversity
 Extinction

Community-ecosystem level
 Disruption of energy flows -Decrease or increase in solar energy uptake and heat output
 -Changes in trophic structure in food chains and webs
 Disruption of chemical cycles
 -Depletion of essential nutrients - excessive nutrient levels
 Simplification -reduction in species diversity - reduction or elimination of habitats
 -less complex food webs
 -possibility of lowered stability
 -possibility of ecosystem collapse

Case study: Mt. St. Helens volcanic eruption 18th may 1980 at MT st Helens Washington state. A large volcanic eruption disrupts the natural order. New populations of flora and fauna were beginning to colonise the harsh environment. The new ecosystem formed and the process of regeneration was observed as the organisms with enough resilience survived and repaired.

b) Human-induced

environmental stress * People play a role in maintaining or disturbing the dynamic equilibrium of any ecosystem. * The impacts of human activity have a global dimension, operating within the context of an interdependent global environment. * Global co-operation is needed to address the threats to the world's biophysical environment. * The causes of environmental degradation in today's world include: - massive population growth - developing world poverty and the crippling burden of debt - non-sustainable agricultural practices in many countries - environmentally damaging industrialisation and exploitation of natural resources, especially in poor countries struggling for export earnings * Each of these issues need to be effectively dealt with if humans are to combat environmental degradation. * Human threats to biodiversity include: - species introductions - habitat destruction - hunting/trade in animal products - pollution * The World Conservation Union's analysis of animal extinctions since 1600 found that 39% resulted from species introductions, 36% from habitat destruction and 23% from deliberate extermination. answer the questions from the information on page 32-33

1. Outline the history of human-induced change. Humans have induced change in ecosystems since very early days in their evolution. The effects have been either caused intentionally or inadvertently. eg: Aboriginals burnt bushland to aid in hunting as well as inadvertently promoting growth and shaping the Australian bushland through natural selection promoting growth.
2. Outline how humans have simplified natural ecosystems and what this has resulted in the need for. Humans have been shaping ecosystems for their benefit. In this process the useful parts of the ecosystem have remained and the other parts have changed or died out.

This process has also simplified the ecosystem in some cases making it unable to support itself. Eg crops, farms require money and time for upkeep.

3. What is the great environmental challenge for humans? The great challenge that humans face with their environment is to maintain a healthy balance between simplified ecosystems and neighbouring complex ecosystems.

4. Outline the ways in which humans modify natural vegetation, and the ability of the affected ecosystems to recover in each case. Human induced change can be either intentional, inadvertent or a result of negligence. The changes made can result in complete ecological destruction but occasionally the ecosystem can adapt due to its resilience and survive with the change.

The Nature of Human-induced Modifications - Human-induced modifications to ecosystems may be either intentional or inadvertent. - In some cases they are the result of negligence on the part of people.

i) Intentional ecosystem change Humans bring about intentional ecosystem change for human benefit. An example of this can be found in the aboriginal burning for easier hunting or simply clearing land and producing food from crops or livestock.

ii) Inadvertent ecosystem change These are changes that are not intended, but occur indirectly as a result of human activity. Meeting the needs and wants of humankind and a rapidly increasing human population will inevitably bring about large-scale environmental change. Unlike other species, humans have the ability to transfer resources from one region to another and to modify ecosystems in order to sustain continued population growth. Examples of human activities and the inadvertent effects they have include: Farming — Reduction of biodiversity, destruction of habitats, soil erosion, introduction of harmful

pesticides killing native flora/fauna. Urbanisation- Total destruction of habitat, fragmentation of habitat destruction of ecosystem linkages, Increased pollution affecting surrounding ecosystems, Destruction of ozone o3 layer through use of cfcs iii) Ecosystem change caused through negligence People sometimes cause environmental change through negligence. Some of the more notorious examples of humanity's failure to protect ecosystems at risk are the: • Explosion of the reactor at the Chernobyl nuclear power plant in the Ukraine • Minamata children being poisoned by mercury accumulated in the food chain • Grounding of the Exxon Valdez in Prince William Sound, Alaska which caused widespread environmental destruction Consequences of human-induced changes . Human induce change is occurring worldwide in ecosystems. . The magnitude and rate of change is closely linked to human population size. . Salinization and desertification are two large scale problems with deforestation a major cause of ecosystem destruction through change. . Almost 11 million ha of land is degraded each year. Takes between 100 and 250 years for topsoil to build up in an area, can be destroyed in less than 10 by human activity.