Environmental Studies
FACT SHEET
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Forests and Nutrient Cycles

Examiners commonly set questions which test students ability to apply their knowledge of the C and N cycle to forest ecosystems. Examiners like these questions because students often:

1. struggle with the key facts of the N cycle
2. find it difficult to apply their knowledge of these cycles to unfamiliar situations

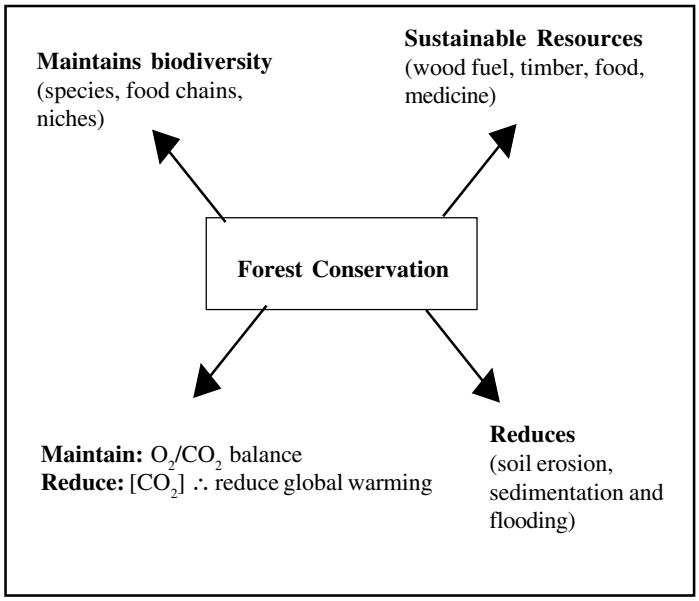
Biological significance of forests

- Forests encourage biodiversity by maintaining shelter, habitats and niches. Don't confuse habitats – the place where an organism lives – and niche which includes an organisms:
  - food sources - use of abiotic resources – light, CO_2, oxygen etc - the way in which it is influenced by abiotic factors – the maximum and minimum temperatures in which it can survive, for example, - the way in which it interacts with other individuals of the same species and with individuals of other species.
- Forests maintain complex food webs – interconnected food chains – involving hundreds or even thousands of different species.
- The forest canopy absorbs or intercepts rainfall, reducing both the volume and the force with which rainfall strikes the soil –thus soil erosion is reduced, which in turn reduces downstream sedimentation and flooding.
- Forests photosynthesise, absorbing carbon dioxide and converting it into organic compounds such as cellulose. In other words they act as a **carbon sink**. Thus, they help reduce atmospheric carbon dioxide levels and global warming.

Tropical forests are under huge threat from logging companies and increasing population. Traditional slash and burn techniques were sustainable when populations were low; a small area of forest would be cleared and used to grow crops. After 3-4 years crop growth would fail - tropical forest soils are relatively infertile and most of the nutrients are in the biomass (Fig 2).

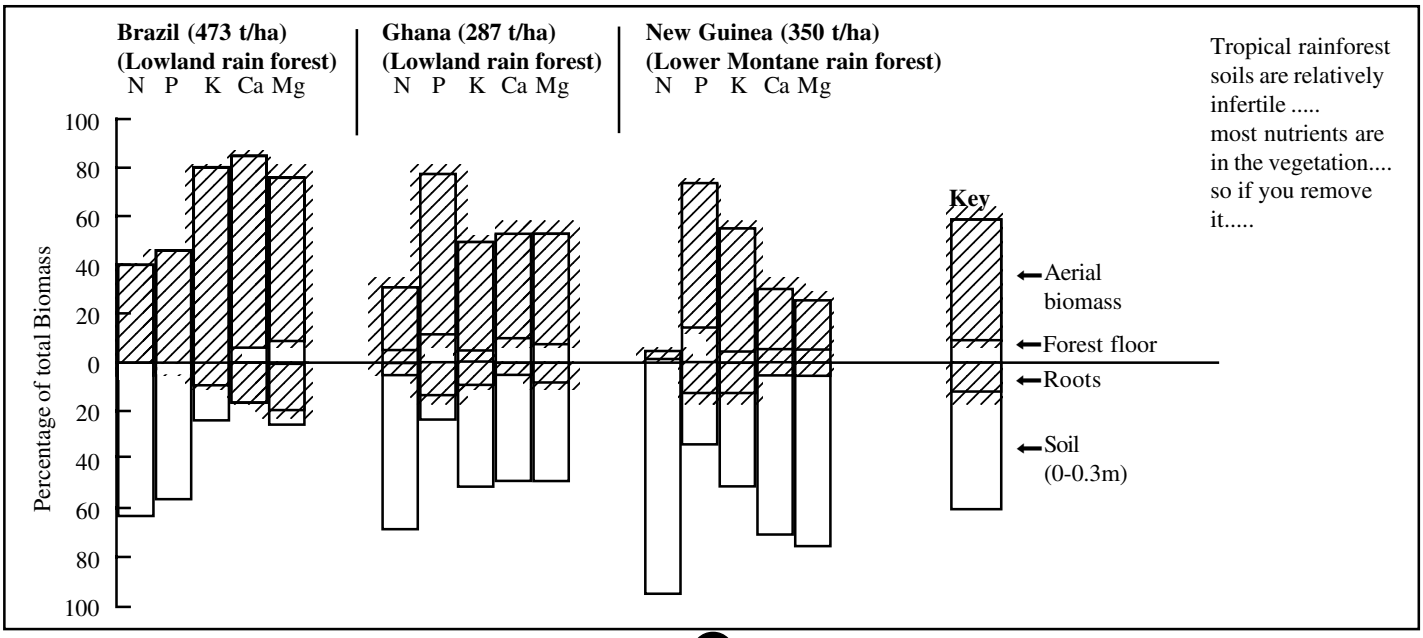
The biological significance of forest is summarised in Fig 1

Fig 1 Biological significance of a forest



The area would then be left for many decades – during which time **secondary succession** would occur - before being cleared again. The increase in population in many areas has meant that areas are not left fallow long enough for regeneration to occur. Crop growth soon fails and farmers turn to manure or artificial fertilisers.

Fig 2. The distribution of inorganic nutrients above and below ground in three Tropical Rainforest (TRF) areas



Applied exam questions often focus on two aspects of this:
1. How does ploughing affect soil N and C levels?
2. How does deforestation affect soil C levels?

Firstly, we need to run through the N cycle with an emphasis on what's useful for crop growth (Fig 3).

As we can see the process of **nitrification** is crucial –it converts ammonium ions (which plants find difficult to absorb) into nitrate ions, which are easily absorbed. So, how can farmers and foresters encourage nitrification? By maintaining aerobic conditions in their soils. Anything that lets air, hence oxygen, into the soil will encourage nitrification.

Ploughing does just that – it breaks up the soil, allowing more air in, and it improves drainage so that water moves down through the soil profile, leaving air spaces behind. Furthermore, ploughing will affect another important part of the N cycle – denitrification.

Bacteria such as *Pseudomonas denitrificans* break down nitrates and ammonium compounds into gases such as nitrogen (N_2) and nitrous oxide (N_2O), which then escape into the atmosphere (thus the cycle is kept going). Denitrification occurs in anaerobic e.g. waterlogged conditions and from the point of view of the farmer or forester it is a Bad Thing – expensive nitrate fertiliser disappears into thin air if it's applied to a boggy field!

Ploughing or draining the soil will help reduce waterlogging and anaerobic conditions – thus reducing denitrification. So far then, ploughing is a Good Thing…….

However, by encouraging oxidation in the soil some useful N-containing compounds may also be lost to plants. This is because allowing more air into the soil will provide more oxygen for aerobic decomposers - microorganisms that are breaking down organic matter in the soil. With increased oxygen, the decomposers will respire more rapidly, and so the rate of decomposition will increase too.

Thus, the breakdown of N–containing proteins and C-containing carbohydrates, fats and proteins will increase, all of which will mean the loss of nitrogen and carbon from the soil in the form of nitrogen oxides and carbon dioxide respectively.

So ploughing can both speed up and slow down some processes which lead to a loss of nitrogen from the soil – the overall (net) effect depends on the precise soil conditions (Fig 4).

The effect of deforestation on soil C stores can be explained in a similar way (Fig 5)

However, deforestation seems to lead to increased breakdown of organic matter, hence increase in concentration of CO_2 in atmosphere, the amount of trees may:
1. reduce the amount of organic matter in soil;
2. lead to drier soils and this may slow the rate of decomposition.

Thus, the precise effect of deforestation on soil C levels is difficult to predict – fortunately exam questions only require you to show that you understand the basic processes!

Fig 3. Crop growth

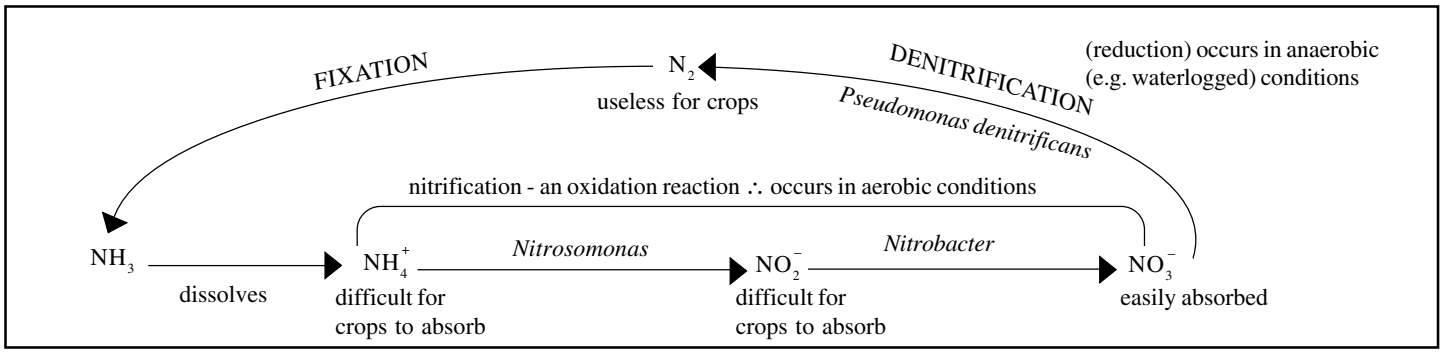


Fig 4. Effect of ploughing on carbon and nitrogen levels in soil

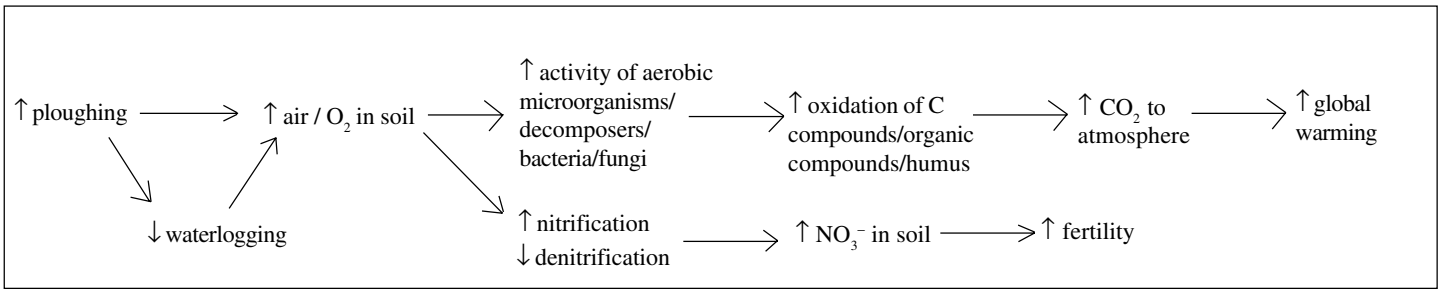
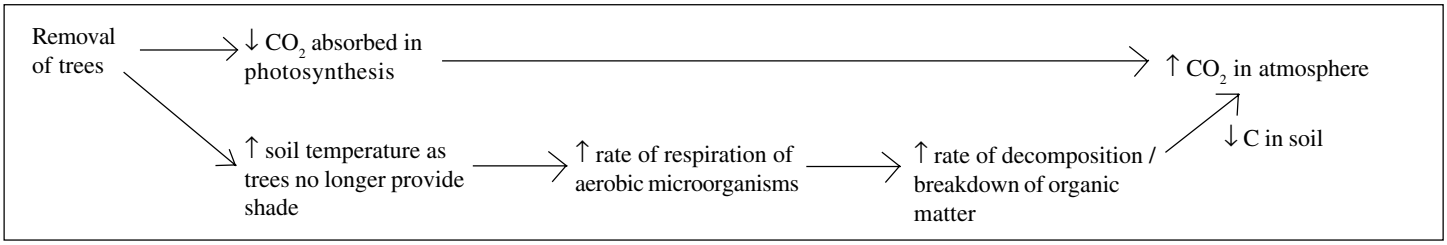


Fig 5. Effect of deforestation on soil carbon levels



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