DECREASING INDUSTRIAL POLLUTION AND IMPROVING AGRICULTURE IN ISRAEL

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The protection of the environment can be performed on three levels. The first is pollution cleanup. Initial efforts are being made in Israel, for example, to clean up oil slicks and treat industrial and domestic sewage. The second level is pollution control. A process, using enzymes in the pulp and paper industry and micro-organisms in the absorption of heavy metals, is currently being developed in Israel. The third level is pollution prevention, where raw materials are renewable, waste material biodegradable, and the final residues can be recycled. For example, sludge can be used as fertiliser. Some agricultural practices being developed in Israel, such as the use of biological agents for disease control, and the transfer of manure from large stocks of farm animals for the production of energy and feed, might fit into this category. Much effort has to be invested in developing processes for sustainable development, together with educational programmes to inform people and promote ideas of sustainable development and a bio-centred life.

Efforts Made by the Israeli Government to Decrease Pollution

The Ministry of the Environment is the main organisation responsible for legislation and the enforcement of laws concerned with the environment. During the last few years, new laws dealing with improvements to the existing laws regarding water contamination, noise pollution, waste handling, work safety and many others, have been approved and ratified. This includes new rules regarding dumping from ships, placement of signs and advertisements, including election propaganda, concentration of handling toxic waste to one site in the Northern Negev, cleanliness at gas stations, work hygiene with regard to asbestos, as well as, a decrease in the use of asbestos, and the closure of 400 small solid-waste dumps for household and other non-toxic waste, situated all over the country. The solid-waste handling will take place at a few, better controlled dumps, some of them to be lined in order to decrease the leakage of unwanted liquids into water resources.

The Gulf War raised awareness of the potential disasters that ecological warfare can lead to; the cormorant bird symbolised the environmental aspect of this war. This led to the intense renewal of instruction in environmental studies at all levels at schools and these studies are now a subject for matriculation. This has lead to close co-operation with the Ministry of Education and 16 educational centres now exist for environmental education. Specific projects are being promoted, including campaigns for cleaning up beaches, involving school children, the stimulation of industry to produce environmentally sound products and of the consumer, to buy them. The improvement of recycling efforts for paper, boxes, batteries, plastic and glass is also being promoted.

The main environmental problem which the ministry has to deal with is the contamination of our water sources. The coastal aquifer is contaminated by sea water, mainly as a result of over-pumping, and the mountain aquifer is contaminated by salt and bacteria. The sewage system is underdeveloped and 2/3 of Israel's sewage is minimally treated. On the positive side is the introduction of highly effective anaerobic treatment for high-organic-load industrial sewage, mainly from the food industry, and the implementation of the law (1990), which forbids the dumping of waste water into the sea. It has been recommended that within 5 to 10 years sewage treatment plants should be built to treat all sewage.

The awareness of the importance of introducing cyclical processes and the idea of sustainable development, is still foreign to most Israelis. Determined efforts on all fronts are needed to inform the population and make them more aware of the necessary changes. There are some developments in industry and agriculture, however, which show an initial willingness to introduce these new principles, leading to new methods of manufacture.

Levels of Sustainability

The development of modern society, with all its more-or-less comfortable practices, has led to the robbing of non-renewable resources and the accumulation of composites which are harmful to our milieu. In the Western world the realisation that we are travelling along a road to nowhere is becoming more and more apparent. The main processes for obtaining most goods and services are the so-called "end-of-pipe" processes, where we take non-renewable raw materials, process them to obtain the desired commodities and, in the process, produce a whole series of waste matter detrimental to the environment.

There are three levels of environmental protection, where many biotechnological methods have been applied to decrease the ecological burden on the surroundings.

Pollution Cleanup

The first level is pollution cleanup, employing processes such as the detoxification of soil using special strains of bacteria, or fertilisation with limiting nutrients, to take advantage of the residential bacterial flora. Another such process is the microbial cleanup of oil slicks. A team at Tel-Aviv University led by Professor E. Rosenberg has been studying the degradation of oil by various bacteria. Even though these bacteria have been known for a long time, the degradation of oil spills, after their addition, has usually not been very effective. This is mainly because of limitation by nitrogen, in most natural habitats. The addition of nitrogen which is water-soluble is not a good answer, since other bacteria will grow. High concentrations of nitrogen are also an environmental nuisance. Therefore non-water soluble nitrogen is added, together with the oil degrading bacteria, and this nitrogen is sufficient, if added at low concentrations. This technology was used by the Tel-Aviv team to clean an oil-contaminated beach north of Haifa. Four months after the treatment the beach had returned to the state it was in before the oil spill, whereas in control areas the pollution still remained.

After the introduction of new laws regarding sewage from the chemical industry in the Haifa Bay area, technologies have been introduced, based on the aerobic degradation of mixtures of chemicals, where bacterial mixtures were selected which were able to decrease the chemical concentration by 85-95%.

Pollution Control

In these processes, efforts are being made to use materials which are low in their environmental load and to change existing materials for others that are more friendly to the environment. One such compound is the dispersing material produced by certain bacteria, which changes the surface tension of chalk stone and is of importance in the paper, ceramics and paint industries. Instead of using toxic chemicals which end up in the effluent water, the bio-dispersing material sticks to the chalk stone, keeping the chalk stone well dispersed.

The selection of bacteria, which selectively bind heavy metals, has been carried out in Israel and several strains have been isolated which are able to absorb heavy metals from process waters of various types. By this method it is possible to decrease the amount, for example, of cadmium, copper and mercury, metals which are toxic and accumulate in the body, remaining there for decades.

Micro-organisms with enzymes (xylanases) are used to bleach pulp and paper, instead of chlorine, in the paper industry, thereby reducing the use of chlorine. Enzymes have also been introduced for degreasing (lipases) in the electroplating industry.

Pollution Prevention

Pollution prevention implies that the process is of a cyclical nature, i.e. all raw materials are renewable, all waste materials are biodegradable and the final residue can be used for practical purposes. The ideal result would be to use technologies which are sustainable and, if possible, would contribute to "unburdening" the environment. In order to quantify sustainability, various indices have been suggested. One of them is the Sustainable Process Index adopted by the working group Sustainable Biotech Development, of the European Federation of Biotechnology.

There are very few, if any, industrial practices which qualify for this category, and the use of renewable raw materials would imply that all industry would be "agro-based." In agriculture it is easier to find developments which get closer to securing pollution prevention. Intensive agriculture means many polluting practices. Today there is an inclination to return to "closed cycling." In Israel, where water is a rare commodity, methods of drip irrigation have been developed to ensure better utilisation of the scarce water sources; biological methods have been introduced to reduce and, it is hoped, to replace chemicals used in disease control in agriculture; the anaerobic degradation of bovine manure from large supplies has resulted both in energy and dried sludge which, has been found to be an excellent feed for pond fish and poultry.

Sustainable Technology and Development

Sustainable technology can be defined by the following statements:

- all material streams are closed to form cycles
- energy requirements are met by solar energy
- basic products (food, cloth, packaging) are derived from renewables, recycled via bio-degradation

- "long-term goods" (shelter, transport, information transfer) can be produced from non-renewable resources, recycled via "technological pathways"
- waste management is governed by absorption capacity
- no mass transfer between renewable and non-renewable cycles
- technology assessment is based on the ability to be part of a closed cycle economy

To achieve sustainable development, defined as "improving the quality of life while living within the carrying capacity of the supporting biosystems," we need to maintain overall quality of life and access to natural resources, while avoiding lasting environmental damage.

Sustainable Process Index (SPI)

Sustainable development must be seen as a dynamic process, including societal development. In practice this means that we have to quantify existing and innovative processes for their impact on the environment, based on ecological principles. The SPI is one way to quantify, based on the concept of the area used to provide a product or service, taking into account the impact on the environment of the whole process, from raw material to generation, the energy supply, product and waste degradation.

In order to calculate the SPI, every stream entering and leaving a process will be identified with an area; areas for energy production and areas for production of process equipment and land use for production facilities. This results in a total area requirement per product or service unit obtained (atot - m2/ product unit). The specific area requirement is related to the mean area per inhabitant in the region where the product will be sold. This relation is the SPI, which is not an absolute measure. It relates the order of magnitude, of land per capita, to the order of magnitude of area needed to generate a certain service or product. The SPI analysis of a process has two possible benefits. It may be used to compare different processes and products in order to measure which is better suited for survival under the conditions of a sustainable economy. It might also help to find more ecologically compatible processes since, it indicates what raw materials, process steps, or product streams, contribute most to the SPI. Fossil raw materials contribute largely to the raw material area since they are also renewable but, on a very different time scale.

The challenge now is to develop processes that integrate environmental protection directly with production processes. To achieve this goal the following biotechnological processes are particularly useful: the replacement of petrochemicals with "biologicals"; the production of "biologicals" using renewable raw materials; and the application (biocentric use) of the full potential of bio-diversity, not limited to micro-organisms.

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