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Indira Gandhi National Open University
School of Interdisciplinary and
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MEV-004
Environmental Toxicology

ENVIRONMENTAL TOXICITY RISK ASSESSMENT

3

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Environmental Toxicology

Block

3

ENVIRONMENTAL TOXICITY RISK ASSESSMENT

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INTRODUCTION TO BLOCK 3

This block focuses on the environmental toxicity risk assessment and estimating health risks. The acceptable limit of toxicants with suitable case studies has been detailed. Risk assessment helps to plan risk minimization strategies. Finally the block focuses on toxic remediation of the air, water and soil environments with suitable case studies.

Unit 1 deals with the acceptable limits of toxicants. The acceptable pesticide limits with reference to national and global scenario and the determination of acceptable risks and limits of environmental toxicants have been described. Further the importance of biomonitoring and the benefits of environmental benchmarking programmes have also been explained.

Unit 2 deals with the toxicity risk assessment planning. The importance of estimating health risks, risk-benefit analysis and managing risks is also detailed. Planning and analyses is essential for understanding and managing risks.

Unit 3 deals with toxicity remediation. The toxic substances can be present in contaminated river or soil and pose threats. Several methods can be employed for remediating the contaminated site. The goals of toxic remediation and detailed treatment mechanisms for the remediation of air, water and soil has been explained.

UNIT 1 ACCEPTABLE LIMITS OF TOXICANTS

Structure

1.0 INTRODUCTION

In this unit you will learn about the standard values of different pesticides widely known as Maximum Residue Limits (MRL's) set by monitoring agencies worldwide as well as in India. You will also gain a detailed insight into a case study depicting the dangerous levels of pesticides which were found in soft drinks like Coca Cola in a breakthrough research conducted by Centre for Science and Environment (CSE). The procedure obtained for the fixation of MRL's has been discussed in an elaborate manner with special reference to India. The significance of Environmental Benchmarks for effective environmental performance has also been discussed in the unit.

1.1 OBJECTIVES

After reading this unit you should be able to:

- understand acceptable limits of toxicants with reference to national and global scenario;
- describe the utility of environmental benchmarks; and
- limitations of environmental benchmarking.

1.2 ACCEPTABLE LIMITS WITH REFERENCE TO NATIONAL AND GLOBAL SCENARIO

Dear Learners, let us know read about acceptable limits with reference to national and global scenario in the following sentences:

1.2.1 Global Pesticide Consumption

The worldwide consumption of pesticides is about two million tonnes per year. The global estimates indicate that around 45% is used by Europe, 25% in the USA, and 25% in the remaining countries while India's contribution is just 3.75%. Only 25% of the cultivated land area is covered by pesticide use on a global scale. The three most regularly used pesticides are gamma-HCH, DDT, and Malathion which relates to around 70% of the total pesticide utilization. Despite the development of newer and much safer pesticide molecules, these obsolete and harmful pesticides are still widely used by small ignorant farmers because of their cost-effectiveness, wide spectrum activity and easy availability over the counter.

1.2.2 Global Scenario

The percentage of global consumption of pesticides for herbicides is 47.5%, for insecticides is 29.5%, 17.5% for fungicides, while others account for 5.5% only. While the U.S. FDA is responsible for the regular inspection including import and export of safe food produce on an international level, the EPA monitors the appropriate levels of pesticide in food produce while defining the MRL of a particular pesticide in a food produce. Many countries like Japan, Canada, Brazil, and Argentina among others have established and follow their own standards. According to WTO, the pesticide standards should be based upon intricate assessments and circumstances as appropriate for evaluating the risks to human, animal or plant life or health and also promote acquiescence with the Codex.

1.2.3 Indian Scenario

The total utilization of pesticides in India is 80% which include insecticides, herbicides, fungicides and others. However, India has low consumption of herbicides as the weeds are removed mostly by hand.

Case Study

Few years ago when CSE, New Delhi claimed the presence of pesticides in some major soft drink brands, it created quite a stir among the public, media as well as Parliament. According to the result, the range of concentration of total pesticides (organochlorines and organophosphorus) was 2.65 ppb to 31.55 ppb in all the 57 samples that were tested. The most commonly reported pesticides were Lindane, Chlorpyrifos, Heptachlor and Malathion. The average concentration of total pesticides detected was 11.85 in all the 57 samples tested, which is reported to be 24 times the BIS limit for total pesticides in soft drinks.

1.2.4 MRL Fixation Procedure in India

Many Asian countries including India have issues regarding the absence of MRL establishment for pesticides in orphan crops, new crops pioneered into countries

and crops which have low yield but have high value in the market. The careless attitude of manufacturers puts the farmer in a fix as without appropriate labels and absence of MRL fixation of pesticides being used or identified, appropriate pest management practices cannot be practiced thus facing the risk of rejection in the international market. The manufacturers also do not promote these practices for they will have to invest more for getting the MRL values fixed for a particular pesticide. The process of registration and usage of pesticides is more complicated in India. Prior to the commencement of use of any new pesticide in the market, it is required to get registered under the Insecticides Act, 1968. The type and the appropriate doses of a particular pesticide to be used on a particular crop are set by The Ministry of Agriculture. The standards set for different pesticides for a particular food commodity or for ingestion by humans are taken care of by The Ministry of Health & Family Welfare. When comparing the data of developing nations like India with the other developed nations of the world like USA, UK or other European nations, it becomes evident that MRL's are much better established and precisely defined in the developed countries when compared to India.

1.3 DETERMINATION OF ACCEPTABLE RISKS AND LIMITS OF 'ENVIRONMENTAL TOXICANTS

A basic approach used to assess the potential risk posed to ecosystems and human health by toxic and other harmful effects of pollutants involves comparison observed concentrations of pollutants in the environment with established **'Maximum Permissible Levels'** and '**Levels of Concern'** (values that trigger action) in corresponding media.

In epidemiological studies, biological monitoring, or bio monitoring, is the assessment of exposure of a population to specific toxic substances by means of systematic or periodic measurements of these substances or their metabolites in human specimens, such as blood, urine, or breast milk, etc. Bio monitoring can be used to establish the body burden or internal dose of specific environmental contaminants through all possible routes of exposure. Population-based bio monitoring, in combination with environmental monitoring (e.g., of air, water, food, and soil), is considered to be one of the most valuable tools in providing information on spatial, temporal, ethnic and socio-economic trends in human exposure to contaminants. Biological monitoring is also becoming widely used in studies linking environmental exposure to pollution-related diseases, for general environmental health monitoring programs, and also to explore body burdens of contaminants in populations that may be at increased risk of exposure. Currently, levels of individual human exposure to the most important Persistent Toxic Substances (PTS) that occur in the Arctic environment are assessed by measuring their concentrations (or those of their metabolites) in blood. The development of adequate analytical instrumentation and protocols, as well as the adoption of effective quality control procedures, makes possible reliable measurement of compounds and their metabolites at very low concentrations.

In spite of numerous advances in techniques, there are still some major challenges in the field of biological monitoring. A number of difficulties have been encountered in determination of specific health effects due to contaminant

exposure in humans and their indicators, which are crucial components of the risk assessment process.

There are various risks involved by coming in contact with a hazard which may involve varied factors like risk involving individual for life span, risk which involves a population on a yearly basis, risk measured on the basis of amplification in percentage or proportion, and loss of estimation of age-at-death.

There are a total of six issues which need to be taken care of in risk assessment patterns.

Firstly, it is not necessary that every individual which comes in contact with a particular hazard will get affected in a negative manner.

Secondly, even if an undesirable reaction occurs after exposure, the incidence and extent of exposure to that particular risk usually depends on the quantity and degree of exposure to a that particular hazard having a threshold value. Many incidents of drug reactions occur due to this model.

Thirdly, the effect of a same dose of exposure can have different effects on people depending on their age, gender; previous incidents of exposure to hazards etc. People with hypersensitive immune systems, the sick, elderly people and newborn may be at a high risk of exposure.

Fourthly, studies for the assessment of human risk for toxicity or hazard measurement are either inadequate or unambiguous. For eg. The carcinogenic potential of a particular compound at a particular dose is different for humans when compared to animal studies.

Fifthly, there are many forms of risks involved with exposure to a particular hazard are deemed suitable and depends on a number of factors such as the number of people coming in contact to a particular hazard, deliberate exposure, the societal significance of the exposure, methods of reimbursement for damage or fatality, and acquaintance with the hazard involved.

Lastly, the criteria established for a particular hazard are uncertain so as to maintain a proper equilibrium of pros and cons for setting up suitable exposure restrictions. For example, the drug tamoxifen is known to be an ovarian carcinogen, but it still being continued for use as a great therapy for treatment of breast cancer.

Production of reliable risk assessments by means of biological monitoring alone is, for certain groups of persistent toxic substances, such as pesticides, still beyond current capabilities. This is due to a lack of detailed knowledge on how to interpret observed concentrations of the substances or their metabolites in various human body fluids and tissues, in particular in the typical situation of integrated exposure to a mixture of different chemicals in combination with other relevant (stress) factors that can influence health.

The best opportunity for the developing a reliable health risk assessment process is afforded by those biological criteria which are based on **‘limit values’** derived from well-designed epidemiological studies and supported by relevant laboratory experiments.

In cases where biological threshold values have not yet been established, judgements regarding guideline levels of a chemical or its metabolites in biological samples can, in many instances, be facilitated by comparison to suggested **reference values (RVs)**. These describe an (acceptable) exposure situation for a given group of the general population to a contaminant. It should be explicitly pointed out that such reference values are strictly statistically-derived values, and are of no health relevance per se. However, RVs are often the only available means by which to assess integrated human exposure to environmental contaminants entering the body through several pathways, when relevant biological limits have not yet been established. The table below describes the Maximum Permissible Concentrations (MPC) for heavy metals in some food items as set by WTO.

Table 1: Maximum Permissible Concentrations (MPC) for heavy metals in food items, and internationally recommended Provisional Tolerable Weekly Intakes (PTWI) (Source: WTO)

Food	MPC, mg/kg ww		
	Lead	**Cadmium**	**Mercury**
Meat and poultry raw	0.5	0.05	0.03
Internal organs of mammals and birds	0.6	0.3	0.1
Kidneys	1	1	0.2
Animal fat	0.1	0.03	0.03
Predatory freshwater fish raw	1	0.2	0.6
Non predatory freshwater fish raw	1	0.2	0.5
Marine fish raw	1	0.2	0.5
PTWI, µg/kg body weight	25	7	5 (total Hg)

1.4 UTILITY OF ENVIRONMENTAL BENCHMARKS

With the rise of various environmental affairs accompanied with mounting obligations in various varied sectors, the increasing expansion and usage of diverse environmental and quality management tools, eco-labels and standards have taken place. Environmental benchmarking is a promising tool which allows studying the gaps and achieving success in filling those gaps by continuous value addition. It is thus intended at recuperating both business and environmental performance concurrently. It helps to provide the participants an overall scenario with respect to its strengths and weaknesses in comparison to the other companies and also gives an overview on the steps required for environmental improvement and thus bridging the gap on an annual basis.

1.4.1 Environmental Benchmarking Principles and Approaches

Environmental benchmarking is basically an act of analyzing and working on the gaps involving environmental matters within a company. Many years ago, this whole procedure was basically a worthless exercise as no company was

really interested in maintaining neither the data nor sharing it in public domain for fear of poor environmental performances. Due to increasing level of environmental awareness, sustainability principles and various other legislations, the scope of environmental benchmarking has increased manifold.

1.4.2 Defining Environmental Benchmarking

It is referred to as an environmental management tool by EEBN, which can provide a significant input to the development of environmental performance by aiding in gap analysis between the performance of a company and a given performance at a time.

1.4.3 The Process of Benchmarking

The process must be initiated by identifying the reason for undergoing the process and analyzing the most appropriate type of benchmarking for the company. The goals for the procedure should be aptly identified and the role of every individual taking part in the process should be clear.

1.4.4 The Scope and Types of Environmental Benchmarking

Environmental benchmarking encompasses various types of benchmarking like benchmarking of responsibility, tactical issues, procedures and performance. Most environmental benchmarking systems majorly revolve around benchmarking environmental performance. It encompasses comparison among the environmental parameters of allied sectors or industries working in the same area.

1.5 TYPES OF COMPARISON POSSIBLE IN THE BENCHMARKING OF ENVIRONMENTAL PERFORMANCE

1) **Comparing performance within a company** against the well defined objectives and purpose as provided in the environmental program
2) **Comparing performance against opponents** which is not always beneficial as it does not give much room for enhancement within the already low performance sector
3) **Comparing performance against well defined sectors** by comparing relevant standards and key figures against parliamentary, eco-labelling or other standards for an ideal environmental performance
4) **Comparing performance against best practice in a relevant sector by** comparing against the best performance in a sector based on major decisive factors

The benchmarking tool can be used in combination with other Eco-tools together on the executive and manufacturing level.

1.6 BENEFITS OF ENVIRONMENTAL BENCHMARKING

- Environmental performance is improved to a considerable level.

- The fiscal performance is also improved.
- Gives an overall picture of the strong points and flaws of a company.
- The previously ignored issues are also recognized.
- Pioneering results are identified.
- Liability in the corporate sector is positively impacted.
- A more positive approach towards the environment and corporate sector is encouraged.

1.7 LIMITATIONS OF ENVIRONMENTAL BENCHMARKING

- Susceptible information is required to be given among allied companies.
- The measurable information needs to be similar among companies.
- The data collected must be dependable and of an excellent quality.

The accomplishment of an environmental benchmarking program lies in creating it as a joint venture between allied companies. The environmental benchmarking should be instigated by an organization as compared to an individual company. This will ensure more positive response for the proper collection of data on environmental parameters.

Check Your Progress 1

Note: a) Write your answers in about 50 words.

b) Check your progress with possible answers given at the end of the unit.

1) Write short notes on utility of environmental benchmarks?

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1.8 LET US SUM UP

In this unit we learnt about:

- Acceptable pesticide limits with reference to National and Global scenario
- Procedure of MRL fixation in India
- Determination of acceptable risks and limits of environmental toxicants
- Role of Bio monitoring as an important tool for environmental health monitoring programs
- Benefits of Environmental Benchmarking Programmes

1.9 KEY WORDS

Environmental Benchmarking: It is referred to as an environmental management tool by EEBN, which can provide a significant input to the development of environmental performance by aiding in gap analysis between the performance of a company and a given performance at a time.

1.10 REFERENCES AND SUGGESTED FURTHER READINGS

1) http://infohouse.p2ric.org/ref/37/36484.pdf

2) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC80780/pdf/20010220s00022p503.pdf

3) http://www.cibrc.nic.in/cropgroup2017.pdf

4) http://www.indiaenvironmentportal.org.in/files/jpc.pdf

1.11 ANSWERS TO CHECK YOUR PROGRESS

Answers to Check Your Progress 1

1) Your answer should include the following points:

With the rise of various environmental affairs accompanied with mounting obligations in various varied sectors, the increasing expansion and usage of diverse environmental and quality management tools, eco-labels and standards have taken place. Environmental benchmarking is a promising tool which allows studying the gaps and achieving success in filling those gaps by continuous value addition. It is thus intended at recuperating both business and environmental performance concurrently. It helps to provide the participants an overall scenario with respect to its strengths and weaknesses in comparison to the other companies and also gives an overview on the steps required for environmental improvement and thus bridging the gap on an annual basis.

UNIT 2 TOXICITY RISK ASSESSMENT PLANNING

Structure

2.0 INTRODUCTION

It is important for hazard evaluations to portray the nature and dangers to humans and ecological receptors (e.g., fishes, birds, animals) from contaminants and different stressors that might be available in the environment. Ecological hazard evaluations regularly can be categorized as:

- Human Health: Think of the many dangers to people who may be exposed to pesticides in water, sustenance, air, and through different exercises. This can result in the utilization of pesticides at home and at work. The four stages of a human wellbeing hazard appraisal are: Hazard Identification, Dose-Response Assessment, Exposure Assessment, and Risk Characterization.

- Ecological: Think of how life, plants, and water sources can be influenced by a pesticide. There are four periods of an environmental hazard appraisal: Planning, Problem Formulation, Analysis, and Risk Characterization.

Following a planning and checking stage where the reason and extent of a hazard appraisal is chosen, the hazard evaluation process more often than not starts by gathering estimations that describe the nature and degree of synthetic sullying in the earth, and data expected to foresee how the contaminants carry on later on.

In light of this, the risk manager assesses the recurrence and extent of human and biological exposures that may happen as an outcome of contact with the polluted medium, both now and later on.

This assessment of introduction is then joined with data on the innate lethality of the concoction (that is, the normal reaction to a given level of presentation) to foresee the likelihood, nature, and size of the antagonistic wellbeing impacts that may happen. In the perfect world, all hazard appraisals would be founded on an extremely solid learning base (i.e., dependable and finish information on the nature and degree of defilement, destiny and transport forms, the greatness and recurrence of human and environmental presentation, and the innate harmfulness of the greater part of the chemicals). In any case, in actuality, data is generally restricted on at least one of these key information required for chance evaluation estimations. This implies hazard assessors regularly need to make gauges and utilize judgment when performing hazard figuring, and thusly all hazard gauges are dubious to some degree. Consequently, a key piece of all great hazard appraisals is a reasonable and open introduction of the vulnerabilities in the figuring and a portrayal of how dependable (or how inconsistent) the subsequent hazard assesses truly are.

Risk manager at that point utilize this data to enable them to choose how to shield people and the earth from stressors or contaminants. Note that "hazard chiefs" can be government or state authorities whose activity it is to secure nature, business pioneers who work at organizations that can affect the earth, or private natives who are settling on choices with respect to chance.

Building up a hazard appraisal is frequently an iterative procedure, which includes scientists recognizing and taking care of information holes keeping in mind the end goal to build up a more refined evaluation of the hazard. This thus may impact the requirement for chance assessors and hazard supervisors to refine the extent of the hazard evaluation additionally setting off the requirement for more information or new presumptions.

2.1 OBJECTIVES

After reading this section you should be able to:

- define perceiving risks;
- describe estimating health risks;
- understand the limitations of toxicity risk assessment;
- explain the risk benefit analysis and
- explain the risk management.

2.2 PERCEIVING RISK

Perception risk is the subjective judgment that individuals make about the qualities and seriousness of a hazard. The expression is most usually utilized as a part of reference to common risks and dangers to nature or wellbeing, for example, atomic power. A few hypotheses have been proposed to clarify why diverse individuals make distinctive assessments of the hazardousness of dangers. Three noteworthy groups of hypothesis have been created: brain science approaches (heuristics and psychological), human studies/social science approaches (social hypothesis) and interdisciplinary methodologies (social enhancement of hazard system).

2.1.1 Psychological Approach

Psychological research approach started with inquires about in attempting to see how individuals process data. These early works keep up that individuals utilize psychological heuristics in arranging and improving data which prompt inclinations in understanding. Later work based on this establishment and turned into the psychometric worldview. This approach recognizes various components in charge of affecting individual impression of hazard, including fear, freshness, disgrace, and different elements.

Research likewise demonstrates that hazard recognitions are impacted by the enthusiastic condition of the perceiver. The valence hypothesis of hazard recognition just separates between positive feelings, for example, joy and good faith, and negative ones, for example, dread and outrage. As indicated by valence hypothesis, positive feelings prompt idealistic hazard observations while negative feelings impact a more critical perspective of hazard.

Research likewise has discovered that, though hazard and advantage have a tendency to be decidedly connected crosswise over perilous exercises on the planet, they are contrarily related in individuals' brains and judgments.

- **Cognitive Psychology:** The larger part of individuals in people in general express a more prominent concern for issues which seem to have a prompt impact on regular daily existence, for example, unsafe waste or pesticide-use than for long haul issues that may influence future ages, for example, environmental change or populace development. Individuals incredibly depend on mainstream researchers to survey the danger of ecological issues since they, for the most part, don't straightforwardly encounter the impacts of marvels, for example, environmental change. The introduction a great many people need to environmental change has been unoriginal; a great many people just have virtual experience however documentaries and news media in what may appear like a "remote" territory of the world. Be that as it may, combined with the populace's sit back and watch state of mind, individuals don't comprehend the significance of changing earth damaging practices notwithstanding when specialists give itemized and clear dangers caused by environmental change.

Check Your Progress 1

Note: a) Write your answers in about 50 words.

b) Check your progress with possible answers given at the end of the unit.

1) Describe risk assessment and its types.

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2) What are perceiving risk?

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2.3 ESTIMATING HEALTH RISKS

There are mainly five stages of health risk assessment:

- **Identification of Issue:** This is a procedure to recognize issues for which hazard appraisal is valuable. It builds up a setting for the hazard evaluation. This is finished by distinguishing the worries that the hazard evaluation needs to address.

- **Identification of Hazard:** It is the way of figuring out what antagonistic impacts are probably going to happen from a presentation to a compound or other substance and whether any unfriendly wellbeing impacts are probably going to happen in people. It inspects the accessible logical information for a given synthetic (or gathering of chemicals or different substances) and builds up a weight of confirmation to describe the connection between the negative impacts and the concoction/other agents.

- **Assessment of Dose Response:** It is the relationship depicts how the probability and seriousness of antagonistic wellbeing impacts (the reactions) are identified with the sum and sort of introduction to the substance.

- **Exposure Assessment for Relevant Population:** It is the way toward estimating or assessing the size, recurrence, and length of presentation to a concoction or other substance in the earth, or evaluating future exposures for a synthetic that has not yet been discharged. An exposure incorporates some talk of the size, nature, and kinds of human populaces presented to the substance, and in addition discourse of the vulnerabilities in the above data. Exposures are ordinarily evaluated in a roundabout way through estimated fixations in nature, models of introduction, and assessments of human admission after some time.

- **Characterization of Risk:** Risk characterization passes on the hazard assessor's judgment with regards to the nature and nearness or nonappearance of dangers, alongside data about how the dangers were evaluated, where presumptions vulnerabilities still exist, and where arrangement decisions should be made

In spite of the fact that they are connected procedures, health impact assessment (HIA) and EHRA address distinctive issues. HIA is characterized by various organizations in diverse ways. HIA is a precise procedure to evaluate the real or potential, furthermore, immediate or roundabout, impacts on the strength of people, gatherings or groups emerging from ecological conditions or risks emerging from strategies, destinations, projects, plans or exercises. It takes a gander at both potential wellbeing advantages and wellbeing impacts from an action or circumstance. It is normally a procedure attempted as a major aspect of an ecological affect appraisal for a huge task and takes a gander at both positive and negative

effects on well-being. HIA is for the most part embraced in the beginning periods of undertaking arranging keeping in mind the end goal to foresee also, encourage shirking of conceivably negative wellbeing impacts, to advance more positive wellbeing impacts and to advance reasonable improvement. It mulls over the social and financial elements.

The meaning of 'health' is taken to be 'a total condition of physical, mental what's more, social prosperity and not just the nonappearance of malady or ailment' (WHO Constitution). This definition has not been modified since it was proclaimed in 1948. In this specific circumstance, EHRA is essentially an instrument for evaluating wellbeing dangers (i.e. unfriendly wellbeing impacts) from contaminant exposures in the more extensive procedure of wellbeing sway evaluation.

Check Your Progress 2

Note: a) Write your answers in about 50 words.

b) Check your progress with possible answers given at the end of the unit.

1) What are the stages of health risk assessment?

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2) Explain health risk assessment.

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2.4 RISK ASSESSMENT PLANNING

Indeed, even a human wellbeing hazard appraisal begins with a decent arrangement. Before anything however there is a need to make judgments early when arranging real hazard evaluations with respect to the reason, extension, and specialized methodologies that will be utilized. To begin, chance assessors will ordinarily ask the accompanying inquiries:

1) Who/What/Where is at risk?

- Person
- Overall public
- Life stages, for example, kids, adolescents, pregnant/nursing ladies
- Populace subgroups - very powerless (for instance, because of asthma,

hereditary qualities, and so forth.) as well as exceedingly uncovered (for instance, in light of geographic region, sex, racial or ethnic gathering, or monetary status)

2) What is the environmental hazard as concern?
   - Chemicals (single or various/aggregate hazard)
   - Radiation
   - Physical (clean, warm)
   - Microbiological or organic
   - Healthful (for instance, eating routine, wellness, or metabolic state)
   - Financial (for instance, access to medicinal services)
3) Where does environmental hazard comes from?
   - Point sources (for instance, smoke or water release from a plant; defilement from a Superfund site)
   - Non-point sources (for instance, car fumes; agrarian spillover)
   - Characteristic sources
4) How does exposure occur?
   - pathways (recognizing that one or more may be involved)
     - Air
     - Surface Water
     - Groundwater
     - Soil
     - Solid Waste
     - Food
     - Non-food consumer products, pharmaceuticals
   - Routes (and related human activities that lead to exposure)
     - Ingestion (both food and water)
     - Contact with skin
     - Inhalation
     - Non-dietary ingestion (for example, “hand-to-mouth” behavior)
5) What does the body do with the environmental hazard and how is this impacted by factors such as age, race, sex, genetics, etc.?)
   - Assimilation - does the body take up the natural risk
   - Dissemination - does the ecological danger go all through the body or does it remain in one place?
   - Digestion - does the body separate the ecological danger?
   - Discharge - how does the body dispose of it?
6) What are the health effects?
   - It includes cancer, heart disease, liver disease and nerve disease

7) How long does it take for an environmental hazard to cause a toxic effect? Does it matter when in a lifetime exposure occurs?

- To what extent?
  - Intense - immediately or inside a couple of hours to a day
  - Subchronic - weeks or months (for people for the most part under 10% of their life expectancy)
  - Constant - a noteworthy piece of a lifetime or a lifetime (for people no less than seven years)
  - Discontinuous
- Timing
  - Is there a basic time amid a lifetime when a synthetic is most harmful (e.g., fetal advancement, youth, amid maturing)?

Check Your Progress 3

Note: a) Write your answers in about 50 words.

b) Check your progress with possible answers given at the end of the unit.

1) Explain the planning in health risk assessment.

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2.5 LIMITATIONS OF TOXICITY RISK ASSESSMENT

- **Absence of significant exposure data**

A fundamental point that was raised alluded to the way that hazard evaluation approaches for the most part are danger driven as opposed to introduction driven. There was general agreement that applicable and dependable data on introduction is restricted or on the other hand not accessible, principally because of the high costs included. This was viewed as a significant proviso, as learning on the inside or outer measurements is essential to relate measurements reaction lethality information to wellbeing dangers in people. It is conceivable that the course of organization in the poisonous quality tests utilized is not quite the same as the most critical human course of presentation, expecting course to-course extrapolation. In instance of lacking or nonattendance of introduction information, default presumptions that are frequently however not generally most pessimistic scenario are made, which thus may prompt an under or overestimation of the hazard related with presentation to a specific substance. Other testing viewpoints incorporate recurrence and length of human introduction, which are not generally mirrored appropriately in danger tests. Additionally total and total exposures, including introduction to blends ought to be taken into account, since it is likely that people are presented to synthetic

substances through various sources and by means of various courses, and to different (dangerous) chemicals in the meantime.

- **Exposure assessment** isn't generally legitimately required and along these lines introduction information is regularly deficient. This shows legitimate systems incredibly figure out which data ought to be given. An entangling factor in this field is that the data prerequisites vary between the different lawful structures. It is moreover vital that administrative structures.

- **Hazard Driven Testing Procedure**

  The present framework depends on creating information by playing out a battery of poisonous quality tests, with fundamentally apical end focuses as the readout for lethality. This approach gives to an (exceptionally) restricted degree understanding into the systems basic poisonous quality, because of which it is regularly alluded to as a 'discovery' approach. It is to an expansive degree danger driven as opposed to presentation driven. This once in a while brings about pointless testing in light of the fact that not all data is dependably required for precise hazard estimation, or to a great degree low human introduction would relieve the need to know the peril (e.g. at the point when beneath the TTC). Moreover, our expanded comprehension of toxicological systems together with developing new advancements isn't reflected in the present system for chance evaluation. Similar to REACH, offer the likelihood to forgo danger data. In any case, despite the fact that this plausibility is routinely utilized, it is frequently not all around established and without an adequate logical premise.

- **Pertinence of Current Methodologies: Substances**

  Another issue set forward was that the danger tests and the testing procedures depicted in the present test rules have not been created for "complex" substances, for example, designed nanoparticles. A portion of the current danger tests might be reasonable to survey the dangerous properties of these materials, while others may not. Appropriate hazard appraisal requires knowledge in the destiny of these nanomaterials in the body, including toxicokinetics, and its relationship with their dynamic physico-concoction properties all through introduction, for example, estimate, shape, solvency and surface properties of the molecule. The large number of conceivable contrasts between these recently created nanomaterials due to e.g. size, structure, or covering, represents an extra test. Not at all like generally standard substances, the danger of nanomaterials does not rely upon compound piece alone, yet on a plenty of molecule properties, entangling the extrapolation of wellbeing information for hazard evaluation purposes, for example, getting introduction limits from one material to another. Subsequently, to have the capacity to survey the security of these extraordinary sorts of materials an alternate approach is required.

2.6 RISK-BENEFIT ANALYSIS

Risk benefit analysis is the correlation of the danger of a circumstance to its related advantages. Presentation to individual hazard is perceived as a typical part of regular daily existence. We acknowledge a specific level of hazard in our lives as important to accomplish certain advantages. In the vast majority of these dangers, we feel just as we have a type of control over the circumstance. For

instance, driving a vehicle is a hazard the vast majority take day by day. The controlling element seems, by all accounts, to be the view of their individual capacity to deal with the hazard making the circumstance.

Investigating the danger of a circumstance is, be that as it may, extremely reliant on the individual doing the examination. At the point when people are presented to automatic hazard, chance which they have no control, they make hazard avoidance their essential objective. Under these conditions, people require the likelihood of hazard to be as much as one thousand times littler than for a similar circumstance under their apparent control.

Future risk evaluation:

- Real future risk as uncovered by the completely developed future conditions when they create.
- Statistical risk, as dictated by as of now accessible information, as estimated actuarially for protection premiums.
- Projected risk, as logically in light of framework models organized from recorded considers.
- Perceived risk, as naturally observed by people.

Check Your Progress 4

Note: a) Write your answers in about 50 words.

b) Check your progress with possible answers given at the end of the unit.

1) What are the limitations of toxicity risk assessment?

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2) Describe risk-benefit analysis.

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2.7 RISK MANAGEMENT

Risk management is the thought of social, monetary and political factors in the basic leadership procedure of controlling dangers. The fundamental undertaking of a hazard administration is to go for broke evaluation and incorporate it with the best accessible sociological, efficient and political data.

As a general rule, the unwavering quality of the information on which hazard and cost estimations depend on frequently drives chance administration to go too far of hazard assessment. Theoretically, in any case, a hazard assessor should adhere to his or her logical approach and present the solid and target data to the hazard director while the hazard chief should take the appraisal at its face esteem incorporating different components settling on the choice.

A risk manager should begin with setting on the variables beneath:

- how much the hazard can be controlled
- the cost of control
- the social and political achievability and worthiness of the control
- the advantages of the item
- how much the hazard taking exercises is willful or automatic

More often than not, the law, the nature of controller, open discernments, and outer weights decide the degree whether the hazard chief can control the motivation. Control strategies can be:

- A restriction on the make or a cutoff on the items utilize. It can be proficient by setting a demonisms chance level beneath which chance is viewed as inconsequential even with immaterial cost. Cases of which are the discharge level and as far as possible per case maintained a strategic distance from or per life spared and so on.
- An innovative control of the produce or utilize. This is normally proficient by the best accessible innovation (BAT). Cases of which are the sheltered drinking water act and the perfect air act.

Since the way toward transmitting logical data from database to basic leadership includes a mind boggling adjusting of positive and negative factors, the more unequivocal the choice, better. Dangers, advantages, and expenses can be communicated quantitatively or subjectively.

As a rule, the result of hazard administration as a rule relies upon singular identities, methods of insight and experiences.

Check Your Progress 5

Note: a) Write your answers in about 50 words.

b) Check your progress with possible answers given at the end of the unit.

1) Explain about risk management.

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2.8 LET US SUM UP

In this unit we have studied about the

- Perceiving risks
- Estimating health risks

- Planning
- Limitations of toxicity risk assessment
- Risk benefit analysis
- Managing risks

2.9 KEY WORDS

Risk benefit analysis: is the correlation of the danger of a circumstance to its related advantages.

Risk management: is the thought of social, monetary and political factors in the basic leadership procedure of controlling dangers.

2.10 REFERENCES AND SUGGESTED FURTHER READINGS

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2.11 ANSWERS TO CHECK YOUR PROGRESS

Answers to Check Your Progress 1

Your answer should include the following points:

1) – It is important for hazard evaluations to portray the nature and dangers to humans and ecological receptors (e.g., fishes, birds, animals) from contaminants and different stressors that might be available in the environment.

   – Human Health

   – The four stages of a human wellbeing hazard appraisal are:

   - Hazard Identification
   - Dose-Response Assessment
   - Exposure Assessment
   - Risk Characterization.

– Ecological: take a gander at how untamed life, plants, and water sources can be influenced by a pesticide.

2) – Perception risk is the subjective judgment that individuals make about the qualities and seriousness of a hazard.

– The expression is most usually utilized as a part of reference to common risks and dangers to nature or wellbeing, for example, atomic power.

– Three noteworthy groups of hypothesis have been created: brain science approaches (heuristics and psychological), human studies/social science approaches (social hypothesis) and interdisciplinary methodologies (social enhancement of hazard system)

– Psychological Approach

– Research likewise demonstrates that hazard recognitions are impacted by the enthusiastic condition of the perceiver.

– Cognitive Psychology

Answers to Check Your Progress 2

Your answer should include the following points:

1) – Identification of issue

– Identification of hazard

– Assessment of dose response

– Exposure assessment for relevant population

– Characterization of risk

2) – Identification of issue

– Identification of hazard

– Assessment of dose response

– Exposure assessment for relevant population

– Characterization of risk

– Health impact assessment (HIA)

– HIA is a precise procedure to evaluate the real or potential, furthermore, immediate or roundabout, impacts on the strength of people, gatherings or groups emerging from ecological conditions or risks emerging from strategies, destinations, projects, plans or exercises.

– The meaning of 'health' is taken to be 'a total condition of physical, mental what's more, social prosperity and not just the nonappearance of malady or ailment' (WHO Constitution).

Answers to Check Your Progress 3

Your answer should include the following points:

1) – Who/What/Where is at risk?

- Person
- Overall public
- Life stages

– What is the environmental hazard as concern?
  - Chemicals (single or various/aggregate hazard)
  - Radiation
  - Physical (clean, warm)
  - Microbiological or organic
  - Healthful (for instance, eating routine, wellness, or metabolic state)
  - Financial (for instance, access to medicinal services)

– Where does environmental hazards comes from?
  - Point sources (for instance, smoke or water release from a plant; defilement from a Superfund site)
  - Non-point sources (for instance, car fumes; agrarian spillover)
  - Characteristic sources

– How does exposure occurs?
  - Pathways (recognizing that one or more may be involved)
    - Air
    - Surface Water
    - Groundwater
    - Soil
    - Solid Waste
    - Food
    - Non-food consumer products, pharmaceuticals
    - Routes (and related human activities that lead to exposure)
    - Ingestion (both food and water)
    - Contact with skin
    - Inhalation
    - Non-dietary ingestion (for example, “hand-to-mouth” behavior)

– What does the body do with the environmental hazard and how is this impacted by factors such as age, race, sex, genetics, etc.?)
  - Assimilation - does the body take up the natural risk
  - Dissemination - does the ecological danger go all through the body or does it remain in one place?
  - Digestion - does the body separate the ecological danger?
  - Discharge - how does the body dispose of it?

– What are the health effects?
  - It included cancer, heart disease, liver disease and nerve disease

– How long does it take for an environmental hazard to cause a toxic effect? Does it matter when in a lifetime exposure occurs?

– To what extent?
  - Intense - immediately or inside a couple of hours to a day
  - Subchronic - weeks or months (for people for the most part under 10% of their life expectancy)
  - Constant - a noteworthy piece of a lifetime or a lifetime (for people no less than seven years)
  - Discontinuous

– Timing
  - Is there a basic time amid a lifetime when a synthetic is most harmful (e.g., fetal advancement, youth, amid maturing)

Answers to Check Your Progress 4

Your answer should include the following points:

1) – Absence of significant exposure data
   – Exposure assessment
   – Hazard driven testing procedure
   – Pertinence of current methodologies: substances
2) – Risk benefit analysis is the correlation of the danger of a circumstance to its related advantages.
   – Presentation to individual hazard is perceived as a typical part of regular daily existence. We acknowledge a specific level of hazard in our lives as important to accomplish certain advantages.
   – In the vast majority of these dangers, we feel just as we have a type of control over the circumstance.
   – Future risk evaluation:
     - Real future risk as uncovered by the completely developed future conditions when they create.
     - Statistical risk, as dictated by as of now accessible information, as estimated actuarially for protection premiums.
     - Projected risk, as logically in light of framework models organized from recorded considers.
     - Perceived risk, as naturally observed by people.

Answers to Check Your Progress 5

Your answer should include the following points:

1) – Risk management is the thought of social, monetary and political factors in the basic leadership procedure of controlling dangers.
   – The fundamental undertaking of a hazard administration is to go for broke evaluation and incorporate it with the best accessible sociological, efficient and political data.
   – hazard assessor should adhere to his or her logical approach and present the solid and target data to the hazard director while the hazard chief should take the appraisal at its face esteem incorporating different

components settling on the choice.

– A risk manager should begin with setting on the variables beneath:
  - how much the hazard can be controlled
  - the cost of control
  - the social and political achievability and worthiness of the control
  - the advantages of the item
  - how much the hazard taking exercises is willful or automatic

– Control strategies can be:
  - A restriction on the make or a cutoff on the items utilizes. It can be proficient by setting a demonisms chance level beneath which chance is viewed as inconsequential even with immaterial cost. Cases of which are the discharge level and as far as possible per case maintained a strategic distance from or per life spared and so on.
  - An innovative control of the produce or utilize. This is normally proficient by the best accessible innovation (BAT). Cases of which are the sheltered drinking water act and the perfect air act.

UNIT 3 TOXICITY REMEDIATION

Structure

3.0 INTRODUCTION

Cleaning up nature is an essential focal point of the green economy. Locales that are dirtied as a result of mechanical action, the utilization of pesticides and compost, or the arrival of different contaminations must be tidied up so as to redevelop them or return them to their normal state.

Before performing natural control, numerous organizations just discharged perilous materials into the earth. They dump chemicals and different toxins onto unused land or into lakes, waterways, and streams. Contaminated destinations that can be cleaned and redeveloped are known as brownfield locales.

Ecological remediation is the expulsion of contamination or contaminants from water and soil. These waste items/poisonous substances are evacuated for the security of human wellbeing.

Remediation extends more often than not start with a site appraisal to decide the expenses of the undertaking, but also the innovation that would be most proper for the specific site.

Appraisals must be made to distinguish any potential perils to the specialists dealing with the undertaking and to evaluate the effect that contamination may have on the nearby group. Once a site is associated with being polluted there is a need to survey the sullying.

The chronicled utilization of the site and the materials utilized and created nearby will decide:

1) The appraisal procedure
2) Type of testing
3) Chemical examination to be finished.

3.1 OBJECTIVES

After reading this section you should be able to:

- define Toxic Remediation;
- describe goals of toxic remediation;
- understand the limitations of remediation of air;
- explain the remediation of water; and
- explain the remediation of Soil.

3.2 GOALS OF TOXIC REMEDIATION

The goals of natural remediation exercises is the convenient and dynamic diminishment of danger and inevitably, if conceivable, the expulsion without limitations of administrative control from the site. Be that as it may, there are circumstances in which the expulsion of control from the site can't practicably be accomplished. In such cases, at any rate the inadmissible dangers to human wellbeing and the earth need to be eliminated. In these cases, any limitations on access to or utilization of the site and some other confinements ought to be set up based on an enhancement procedure in order to boost the net advantage to society. In the decision of the advanced remediation alternative, a wide assortment of elements ought to be considered, and impacts on wellbeing, security and the earth ought to be viewed as together with specialized, social and money related elements. Non-radiological dangers ought to be considered in conjunction with the radiological perils. Remediation should to be done for reducing existing exposures and the potential for delayed exposures to happen later on. Remediation should:

- Decrease natural effects from the radionuclides introduced in the polluted site.

Decreases in the dosages to people and lessened natural effects should be accomplished by methods for intercessions to expel the current wellsprings of tainting, to change the pathways of introduction or to diminish the quantities of people or different receptors presented to radiation from the source.

The level of exertion related with arranging an ecological remediation depends on the unpredictability of the remediation(s) to be performed. Huge, convoluted destinations for the most part get a lot of exertion amid the arranging stage, while littler locales may not require as much arranging. This evaluated approach characterizes healing necessities as indicated by the sort of natural remediation action(s) being planned, the danger of settling on a choice mistake in light of the information gathered, and the results of making such a blunder. This approach gives a more powerful ecological remediation configuration joined with a reason for judging the convenience of the information gathered.

An ecological remediation program ought to have plainly communicated targets. The

underlying ecological remediation destinations ought to be set up based on the nature and degree of the defilement, the water assets that are right now or possibly debilitated, and the potential for human and ecological introduction. These quantitative objectives ought to characterize the degree of tidy up that is required to fulfill the built up destinations. They incorporate the required tidy up levels and the rebuilding time allotment.

Past practices far and wide have utilized to a great degree traditionalist situations for deciding the dangers of ionizing radiation to human wellbeing. Thus, natural healing exercises have turned out to be amazingly expensive. As of late, a rationality of utilizing more practical hazard situations seems to be getting satisfactory. At times, natural remediation has been maintained a strategic distance from by and large, with just the cost of checking remaining. This procedure has diminished the cost while proceeding to satisfactorily secure human wellbeing. It is prescribed that while choosing and investigating the hazard situations, the normal land utilized, the effects influenced and the future groundwater needs should all be assessed. A practical situation would then be able to be created which would take into account a more financially savvy natural remediation while as yet guaranteeing the wellbeing of people in general. Clearly, the adequacy and the unwavering quality of institutional controls may influence these choices.

Hazard appraisal techniques might be utilized, combined with administrative prerequisites, to decide achievable remediation objectives. The gainful utilization of an aquifer ought to likewise be considered. Water which does not meet the required guidelines for household utilize may in any case be helpful for agrarian or modern purposes. At last, the potential impacts on ecological receptors, for example, plant and creature species at or close to the site may likewise influence the remediation objectives.

In the event that the ecological remediation is advocated and any tidy up activity advanced, criteria are expected to target natural remediation exercises, to evaluate execution as the work continues, and to check that the natural remediation has been accomplished at its decision. These criteria might be communicated as far as reference levels of lingering measurements, i.e., the anticipated dosage from the future utilization of the remediated site, or regarding focus limits from which the remaining measurement, through a pathway examination, can be figured. Where important, reentry criteria might be built up by which it can be chosen whether to permit the arrival of the populace and additionally reuse of the land for farming, etc.

Check Your Progress 1

Note: a) Write your answers in about 50 words.

b) Check your progress with possible answers given at the end of the unit.

1) What are the goals of toxic remediation?

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3.3 REMEDIATION OF AIR

Ordinarily, the removed air must be dealt with before outflow. The accompanying treatment strategies are commonly utilized for separated air:

- Granular active carbon (GAC)
- Catalytic oxidation
- Direct incineration
- Biological filters

It is most basic to utilize enacted carbon channels to treat the removed air before it is radiated. The upsides of initiated carbon channels are that the technique is simple and sheltered, both for little wind streams and high fixations. Moreover, buy of the hardware is generally modest. Then again, the gear is costly to work, and there are frequently clamor issues. Enacted carbon channel hardware likewise requires a great deal of supervision, especially toward the start where carbon must be changed every now and again. At last, take note of that the impact relies upon temperature and the piece of the defilement.

Catalytic oxidation is shabby to work as the technique is self-controlled and evacuation happens with no basic results. Then again, buy of the hardware is costly and the strategy requires high groupings of contaminants.

Similarly as with the synergist technique, buy of natural channel gear is costly, however task is economical.

3.3.1 Bioventilation

Bioventilation is the vigorous microbial technique to remove xenobiotic substances in the environment. Various bioventilation screens are introduced in the unsaturated zone. Air is blown in utilizing a ventilator, and decay of the defilement is carried out. More often than not, various aloof 'air-discharge screens' are situated at fitting separations relying upon the qualities of the sullying. Bioventilation empowers biodegradation by blowing noticeable all around, not at all like soil vapor extraction where tainting segments are drained out of the dirt.

It appears that the technique is most appropriate for remediation of lighter, vigorously degradable natural contaminants (mineral-oil items and solvents, yet not chlorinated solvents) in porous soil composes. The strategy is likewise most appropriate for substances with a low to direct vapor weight. Something else, there is a hazard that the substance will be stripped before it is corrupted. Air porousness tests and bioactivity tests ought to be performed when outlining the gear, with a view to discovering the wind stream and the corruption capability of the site.

Check Your Progress 2

Note: a) Write your answers in about 50 words.

b) Check your progress with possible answers given at the end of the unit.

1) What are the treatment strategies commonly utilized for separated air?

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2) Describe bioventilation method.

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3.4 REMEDIATION OF WATER

There are different standards and techniques for remediation of water pollution. The decision of remedial system in a particular circumstance relies upon the accompanying elements:

- Kind of pollution and composition.
- Position of the pollution and also the pollution's degree and seriousness.
- Hydrogeological conditions (pressure driven parameters, kind of aquifer, hydrological bowl, and so forth).
- Time required for remediation.
- Site conditions.
- Need of pressure driven control.
- Measure of speculation and working and support costs.

3.4.1 Pump and Treat Method

Pumping from more profound aquifers is commonly performed from screened wells. Keeping in mind the end goal to bring a pollution under water powered control, a pumping technique must be readied. A pumping methodology incorporates the following:

- Location of pump wells
- Number of pump wells
- Pump yield
- Pump levels

Contingent upon the circumstance, various distinctive techniques are accessible to satisfy the pumping procedure. These incorporate customary pump-and-treat from screened wells, partition pumping, skimming, infusion, distribution, or conceivably a mix of strategies.

In situations where defilement comprises of a light non-aqueous phase fluid (LNAPL) on the groundwater, it is common to evacuate the LNAPL by skimming before elective therapeutic strategies are begun. In the event that a LNAPL e.g. petroleum and oil is available, broad drawdown of the groundwater table ought to be kept away from as this will make the sullying smear the uncovered soil where it can't be expelled utilizing straightforward techniques. Utilizing a few wells with a littler drawdown, potentially with the guide of vacuum to expel air and water all the while, can be the ideal arrangement in these cases.

In situations where there is groundwater pollution close to the ground surface, it is regularly invaluable to use channels associated with a gathering sump from which groundwater is pumped. This arrangement is especially pertinent regarding exhuming, as the strategy more often than not requires broad unearthing. Suction-test hardware might be suitable for brief span drawing in sand aquifers close to the surface (max. 5-7m conveyance head).

Bioslurping is a moderately new strategy, which on a fundamental level is a further advancement of the suction-test system. By utilizing a vacuum, both fluid and air are evacuated in the meantime through a flexible suction pipe which can be situated in traditional wells. The well opening must be fixed to keep up a vacuum.

3.4.2 *In-situ* Method

Air sparging has as of late been utilized as a part of Denmark. Air sparging suggests physical evacuation and microbial corruption of pollution in the groundwater by blowing, for instance, climatic air underneath the groundwater table. Air is blown beneath the groundwater table so unstable segments are stripped and exchanged from the water stage to the unsaturated zone, where they should be evacuated utilizing different systems. Besides, microbial decay in the groundwater zone is fortified as a result of the additional oxygen.

Only few of finished air-sparging remediations are known, yet the strategy is considered to have a future in Denmark on the off chance that it is joined with different strategies, e.g. soil vapor extraction for natural unstable defilement under homogenous topographical conditions. The topography is a definitive factor in that a sensible measure of homogeneity in the media is required. This is especially critical for remediating chlorinated solvents since stripping is the main expulsion system.

Keeping in mind the end goal to decide if a site is proper for this technique, and to outline the framework, an all-around composed pilot test ought to be directed as air-sparging/tracer tests in the supply where the framework is to be introduced.

A related strategy, created from air sparging, is biosparging. In this strategy, the essential goal is to animate the organic procedure. Here, the oxidizing specialist is included heartbeats under lower weights.

Another strategy, which was first utilized as a part of remediations in Denmark in 1997, is to include the oxidizing operator or Oxygen Release Compound (ORC) to the groundwater zone. The technique is generally new in the USA, however it has turned out to be exceptionally effective over a brief period. The technique is reasonable and earth amicable, and it will most likely end up boundless in Denmark.

It is conceivable to cut-off groundwater sullying by building up vertical obstructions in the groundwater aquifer. This should be possible utilizing different strategies, for example,

sheet heaping, exhuming techniques, slurry dividers, penetrating techniques, profound, oil blending (DSM) and grouting. The diverse strategies utilize distinctive materials for the obstructions, for example, betonite, and conceivably in blend with various kinds of plastic boards (geo-films). The strategies have been connected at numerous destinations abroad, however still can't seem to be utilized as a part of Denmark. It is important to know about the material science and area of the defilement, also as conceivable issues with groundwater moving down. In this manner, it can be helpful to build boundaries as a channel prompting a penetrable door (pipe and entryway procedure) where a responsive porous hindrance can be developed in the door territory.

Responsive penetrable dividers are obstructions which permit the entry of groundwater, yet which corrupt or expel defilement from groundwater amid the section. The technique is at a test organize in Denmark, yet it is utilized as a part of the field in the USA for corrupting chlorinated mixes with press filings as the receptive material in the boundary. Furthermore, materials can be utilized with especially high sorption properties, e.g. dirt minerals or dynamic carbon. The hindrances might be dispensable or reusable modules. This technique may have a future in Denmark.

Check Your Progress 3

Note: a) Write your answers in about 50 words.

b) Check your progress with possible answers given at the end of the unit.

1) The decision of remedial system in a particular circumstance relies upon some accompanying elements. Justify.

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2) Explain the types of remediation of water.

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3.5 REMEDIATION OF SOIL

A solution for the issue of soil pollution is soil remediation. It is a method for decontaminating and reviving the soil. It is the way toward evacuating contaminants with a specific end goal to ensure both the soundness of the populace and the earth. To put it plainly, the objective of the procedure is to reestablish the dirt to its regular, contamination free state.

3.5.1 Physico-chemical Methods

Removal and Treatment of Contaminated Soil

One of the least difficult physical techniques for remediation is by expelling the polluted soil and supplanting it with clean soil. Basically it is a dig, dump and replace system. Such a technique is for all intents and purposes conceivable just if the spatial degree and profundity of the polluted area is little. The uncovered defiled soil can be either arranged off in a designed landfill or subjected to straightforward washing.

Nonetheless, washing method is for the most part reasonable for granular soils with less earth content and sullied with inorganic toxins. For dirt ruled soils, a concoction scattering operator should be added to deflocculates and after that compound washing is utilized to break the maintenance of contaminants with the earth surface. Incineration is proposed for soils tainted with natural contaminations. In the event that, it is important to evacuate natural toxins then certain solvents or surfactants are utilized as washing agents.

The strategy is specifically connected in situ where dissolvable, surfactant arrangement or water blended with added substances is utilized to wash the contaminants from the soaked zone by infusion and recuperation framework. The added substances are utilized to upgrade contaminant discharge and portability bringing about expanded recuperation and consequently diminished soil pollution.

Vacuum Extraction

This strategy is a standout amongst the most generally utilized as a part of situ treatment innovations. The strategy is savvy yet tedious and incapable in water soaked soil. The system, as delineated in Fig. 4.3, is valuable for removing debased groundwater and soil vapor from a constrained subsurface profundity. The sullied water is then subjected to standard substance and organic treatment systems. Vacuum method is likewise valuable when soil-water is tainted with volatile organic compound (VOC). The technique is then named as “air sparging”. Now and then biodegradation is clubbed with air sparging for upgraded expulsion of VOC. Such a procedure is then named as biosparging.

The vacuum extraction test is constantly set in the vadoze zone. The accomplishment of the technique relies upon the volatilization of VOC from water into air show in voids. An infusing medium is utilized to remove soil-water or potentially soil-air. At the point when oxygen is utilized rather than nitrogen as the infusing medium, it upgrades high-impact biodegradation.

Soil structure impacts a ton on the section of removed water and vapor and consequently on the achievement of vacuum extraction system. It isn’t just critical that the infusing medium is conveyed productively yet in addition the separated item achieves the exit with less obstruction. Granular soils give better section where as the nearness of mud and natural issue blocks the transmission of both liquid and vapor. Natural issue gives high maintenance prompting less volatilization. High thickness and water content additionally limit transmissivity. Aside from soil, the VOC properties, for example, solvency, sorption, vapor weight, fixation and so on additionally impact the extraction procedure.

Solidification and Stabilization

This is the way toward immobilizing harmful contaminants so it doesn’t have any impact transiently and spatially. Stabilization-solidification is performed in single step or in two stages. In single step, the contaminated soil is blended with an uncommon folio so

dirtied soil is settled and rendered insoluble. In two stage process, the dirtied soil is first made insoluble and non-receptive and in the second step it is cemented. SS process is for the most part supported for exceedingly dangerous toxins. In-situ SS process is for the most part impacted by the transmissivity qualities of the dirt, consistency and setting time of the cover. All around compacted soil, high earth and natural substance don't support in-situ SS.

In ex-situ techniques, dirtied soil is first crushed, scattered, and afterward blended with folio material. The resultant SS material should be arranged in a very much contained landfill. It is basic that the resultant SS item does not experience draining. The regular folios utilized as a part of training incorporate bond, lime, fly cinder, muds, zeolites, pozzolonic items and so on. Natural fasteners incorporate bitumen, polyethylene, epoxy and saps. These natural fasteners are utilized for soil sullied with natural poisons.

3.5.2 Chemical Decontamination

This strategy is for the most part relevant for those dirts which have high sorbed centralization of inorganic heavy metals (IHM). The principal procedure in this strategy is to comprehend the idea of holding between the toxin and the dirt surface. An appropriate extractant should be chosen for selective sequential extraction (SSE) of IHM from the dirt mass. The extractants incorporate electrolytes, powerless acids, complexing operators, oxidizing and decreasing specialists, solid acids and so on. The utilization of these extractants in single or in blend will rely on the centralization of IHM and nature of the dirt mass.

In-situ application (as delineated in Fig. 4.4) of extractants would expel IHM from the dirt surface and go into the pore water. The pore water is pumped and treated (pump and treat strategy) on the ground. While treating the pumped water, both extractants and IHM are evacuated.

Another technique is to permit the defiled pore water to move through a preamble reactive barrier (PRB). Henceforth the situation of the hindrance is dictated by the heading of stream of ground water. The material stuffed in the hindrance will hold IHM by trade (sorption), complexation or precipitation response. The transmission and the response time decide the thickness of the receptive obstruction to be given. The material to be given in the hindrance is affected by the learning of IHM to be expelled. This is principally because of the way that the previously mentioned response happens distinctively when IHM is available as single or as different species.

The effective utilization of PRB or treatment wall (TW) relies on its area with the end goal that larger part of the tainted groundwater moves through it. It is fundamental to have a decent information on the hydrogeological conditions where such hindrances should be set. Now and again, sheet heap dividers are utilized to bind the stream towards the porous boundary. A portion of the materials utilized as a part of PRBs are trade gums, actuated carbon, zeolites, different biota, ferric oxides, ferrous hydroxide and so on. Water powered conductivity of the PRB ought to be more noteworthy than or equivalent to the encompassing soil for legitimate saturation to happen. The learning on response energy and porousness of the obstruction would decide the thickness of the divider to be given to such an extent that enough habitation time is accomplished for the expulsion response to happen.

3.5.3 Biological Method

Electro-dynamic strategies are well known field strategy for sterilizing a specific site by utilizing electrical standards. The strategy is more powerful for granular sort of soils.

Two metal terminals are embedded into the dirt mass which goes about as anode and cathode. An electric field is built up over these cathodes that produces electronic conduction and additionally charge exchange amongst terminals and solids in the dirt water framework. This is accomplished by applying a low power coordinate current crosswise over terminal sets which are situated on each side of the polluted soil. The electric current outcomes in electrosmosis and particle relocation bringing about the development of contaminants from one terminal to the next. Contaminants in the dirt water or those which are desorbed from the dirt surface are transported to the terminals relying on their charges. Contaminants are then gathered by a recuperation framework or saved at the terminals. At times, surfactants and complexing specialists are utilized to encourage the procedure of contaminant development. This technique is financially utilized for the expulsion of overwhelming metals, for example, uranium, mercury and so on from the dirt.

3.5.4 Electro-kinetic Method

Thermal method incorporate both high temperature (>5000C) and low temperature (<5000C) strategies and are generally helpful for contaminants with high volatilization potential (Evangelou 1998). High temperature forms incorporate burning, electric pyrolysis, and in-situ vitrification. Low temperature medications incorporate low temperature cremation, warm air circulation, infrared heater treatment, warm stripping. High temperature treatment includes finish pulverization of contaminants through oxidation. Low temperature treatment builds the rate of stage exchange of contaminants from fluid to vaporous stage thereby causing contaminant division from the dirt. Radio recurrence (RF) warming is utilized for in situ warm disinfecting of soil having unpredictable and semi-unstable natural contaminants. Steam stripping or warm stripping is another procedure valuable for soils defiled with unstable and semi-unpredictable natural contaminants. It is an in situ process in which hot air, water or steam is infused into the ground bringing about expanded volatilization of contaminants. Now and again vacuum is connected to extricate air or steam back to the surface for promote treatment. The adequacy of this technique is expanded by the utilization of synthetic specialists that are fit for expanding the instability of the contaminants. High cost and its inadequacy with a few contaminants (with low volatilization potential) make warm technique less alluring. Additionally, now and again cremation process delivers more lethal gases.

Check Your Progress 4

Note: a) Write your answers in about 50 words.

b) Check your progress with possible answers given at the end of the unit.

1) Describe the physico chemical methods for remediation of soil.

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2) Explain the biological methods involved in remediation of soil.

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3) Describe the electro-kinetic method in soil remediation.

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3.6 LET US SUM UP

In this unit we have studied about the

- Toxic Remediation
- Goals of toxic remediation
- Remediation of air
- Remediation of water
- Remediation of Soil

3.7 KEY WORDS

Granular active carbon (GAC) -Catalytic oxidation -Direct incineration -Biological filters Pump and treat method- Bio slurping- In-situ method- Air sparging- Addition of oxidizing agents- Impermeable cut-off walls- Reactive preamble walls.

3.8 REFERENCES AND SUGGESTED FURTHER READINGS

"Contaminated-Air-Remediation Strategies", Alan Kandel (December 2012)

"Environmental Studies" , Osmania University, Hyderabad, India

"Getting to the core of environmental remediation", IAEA

"Guidelines on Remediation of Contaminated Sites", Environmental Guidelines No. 7 2002 Vejledning fra Miljøstyrelsen

"Remediation of Contaminated Sites", Arezoo Dadrasnia, N. Shahsavari and C. U. Emenike

Wei, Xiangying, et al. "Phylloremediation of Air Pollutants: Exploiting the Potential of Plant Leaves and Leaf-Associated Microbes." *Frontiers in plant science* 8 (2017): 1318.

3.9 ANSWERS TO CHECK YOUR PROGRESS

Answers to Check Your Progress 1

Your answer should include the following points:

1) – Decrease the measurements to people or gatherings of people being uncovered;

– Turn away measurements to people or gatherings of people that are probably going to emerge later on;

– Keep or decrease natural effects from the radionuclides introduce in the polluted site.

Answers to Check Your Progress 2

Your answer should include the following points:

1) – Granular active carbon (GAC)

– Catalytic oxidation

– Direct incineration

– Biological filters

2) – Bioventilation is the vigorous microbial corruption of xenobiotic natural substances in the unsaturated zone, for instance through the expansion of climatic air or oxygen.

– Various bioventilation screens are introduced in the unsaturated zone. Air is blown in utilizing a ventilator, and decay of the defilement is empowered.

– More often than not, various aloof 'air-discharge screens' are situated at fitting separations relying upon the qualities of the sullying.

– Bioventilation empowers biodegradation by blowing noticeable all around, not at all like soil vapor extraction where tainting segments are drained out of the dirt.

– It appears that the technique is most appropriate to remediation of lighter, vigorously degradable natural contaminants (mineral-oil items and solvents, yet not chlorinated solvents) in porous soil composes.

– The strategy is likewise most appropriate for substances with a low to direct vapor weight. Something else, there is a hazard that the substance will be stripped before it is corrupted.

– Air porousness tests and bioactivity tests ought to be performed when outlining the gear, with a view to discovering the wind stream and the corruption capability of the site.

Answers to Check Your Progress 3

Your answer should include the following points:

1) – Kind of pollution and composition.
   – Position of the pollution and also the pollution's degree and seriousness.
   – Hydrogeological conditions (pressure driven parameters, kind of aquifer, hydrological bowl, and so forth).
   – Time required for remediation.
   – Site conditions.
   – Need of pressure driven control.
   – Measure of speculation and working and support costs.

2) – Pump and treat method
   – Bio slurping
   – In-situ method
   – Air sparging
   – Addition of oxidizing agents
   – Impermeable cut-off walls
   – Reactive preamble walls

Answers to Check Your Progress 4

Your answer should include the following points:

1) – Removal and treatment of contaminated soil
   – Vacuum Extraction
   – Solidification and stabilization
   – Chemical Decontamination

2) – Electro-dynamic strategies are well known field strategy for sterilizing a specific site by utilizing electrical standards. The strategy is more powerful for granular sort of soils.
   – Two metal terminals are embedded into the dirt mass which goes about as anode and cathode.
   – An electric field is built up over these cathodes that produces electronic conduction and additionally charge exchange amongst terminals and solids in the dirt water framework.
   – This is accomplished by applying a low power coordinate current crosswise over terminal sets which are situated on each side of the polluted soil.
   – The electric current outcomes in electrosmosis and particle relocation

bringing about the development of contaminants from one terminal to the next.

- Contaminants in the dirt water or those which are desorbed from the dirt surface are transported to the terminals relying on their charges.
- Contaminants are then gathered by a recuperation framework or saved at the terminals.
- Surfactants and complexing specialists are utilized to encourage the procedure of contaminant development.
- This technique is financially utilized for the expulsion of overwhelming metals, for example, uranium, mercury and so on from the dirt.

3) – Thermal method incorporate both high temperature (>5000C) and low temperature (<5000C) strategies and are generally helpful for contaminants with high volatilization potential.

- High temperature forms incorporate burning, electric pyrolysis, and in-situ vitrification.
- Low temperature medications incorporate low temperature cremation, warm air circulation, infrared heater treatment, warm stripping.
- High temperature treatment includes finish pulverization of contaminants through oxidation.
- Low temperature treatment builds the rate of stage exchange of contaminants from fluid to vaporous stage there by causing contaminant division from the dirt.
- Radio frequency (RF) warming is utilized for in situ warm disinfecting of soil having unpredictable and semi-unstable natural contaminants.
- Steam stripping or warm stripping is another procedure valuable for soils defiled with unstable and semi-unpredictable natural contaminants.
- It is an in situ process in which hot air, water or steam is infused into the ground bringing about expanded volatilization of contaminants.
- The adequacy of this technique is expanded by the utilization of synthetic specialists that are fit for expanding the instability of the contaminants.
- High cost and its inadequacy with a few contaminants (with low volatilization potential) make warm technique less alluring.