Econ 275 – Environmental Economics

Chapter 18 Lecture – Water Pollution

1

Nature of Water Pollution Problems

- **Types of Waste-Receiving Water**
  - **There are two general types of water bodies at risk of contamination from pollution.**
    - **Surface water includes rivers, lakes, and oceans. Historically, clean-up policies have focused on surface water.**
    - **Groundwater is subsurface water.**
    - **Both groundwater and surface water are used for irrigation and drinking.**
    - **Surface water also provides additional benefits such as recreation and wildlife.**

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2

Nature of Water Pollution Problems

Water sources have been treated as common property. Thus, they have been used as a cheap place to dump municipal sewage and industrial waste.

Groundwater and surface water require different water policies.

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Nature of Water Pollution Problems

- **Sources of Contamination**
  - **Point source pollution is discharged into surface water at a specific location through a drainage pipe or ditch.**
    - **The primary point sources are industries and municipalities. Point sources are relatively easy to monitor and predict.**
  - **Nonpoint source pollution is runoff that comes from a variety of sources and includes agricultural and urban runoff.**
    - **Nonpoint sources are much more difficult to control due to the unpredictability and uncertainty associated with the exact source.**

4

4

Nature of Water Pollution Problems

- **Rivers and lakes: The primary point sources are industries and municipalities. The primary nonpoint sources involve agricultural activity of different forms.**
  - **The contamination of groundwater usually comes from the migration of harmful substances.**
- **Ocean Pollution: The primary sources of ocean pollution are oil spills and ocean dumping.**
  - **Though not uncommon, oil spills have decreased since 1970.**
  - **Dumped materials include sewage and sewage sludge, unwanted chemicals, trace materials, and radioactive materials**

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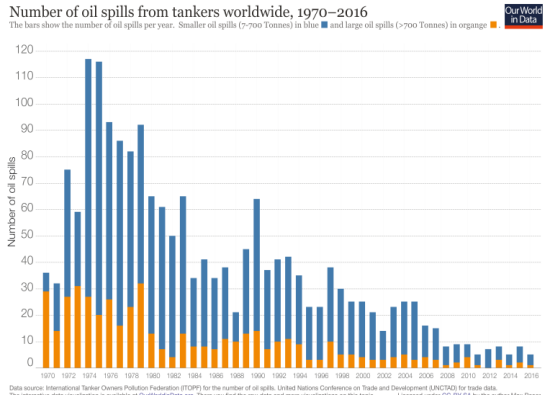

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Types of Pollutants

Fund Pollutants - These pollutants can be assimilated by water sources if the absorptive capacity of the lake or river is high relative to the discharge.

- **Degradable wastes will break down in the water. This process uses oxygen.**
- **Large amounts of degradable pollutants can consume enough oxygen to turn an aerobic stream into an anaerobic stream.**
- **Without oxygen, aquatic lifeforms will die.**
- **Controlling the waste load requires monitoring the ambient conditions in the watercourse and monitoring the magnitude of emissions.**

7

7

Types of Pollutants

- **Dissolved oxygen (DO) is the measure used to monitor ambient conditions.**
- **Biochemical oxygen demand (BOD) is the measure of oxygen demand placed on a stream by any particular volume of effluent.**
- **Oxygen sags represent locations along the stream where the DO is lower than at other points.**
- **Policy options could focus on a general BOD reduction target (emission permit or emission charge).**
- **Ambient control programs (ambient permits or ambient charges) would be aimed at reaching a particular DO target at the oxygen sags.**

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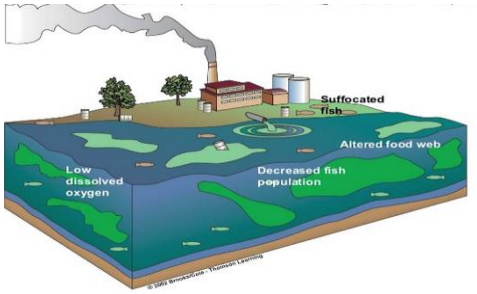
Thermal Pollution

Thermal pollution stems from the injection of heat into a watercourse. Usually this is in the form of used coolant water. Raising the temperature of the water reduces DO.



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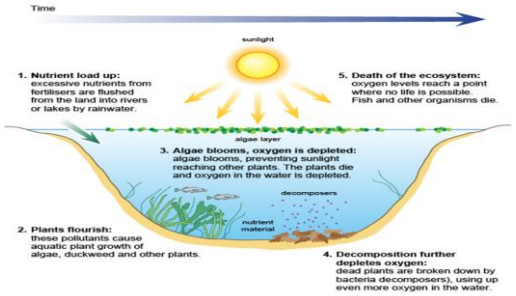
Eutrophication

Plant nutrients such as nitrogen and phosphorous cause algae growth. Too many nutrients in a stream or water body can cause eutrophication.



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Types of Pollutants

Stock pollutants - those for which the environment has no absorptive capacity.

- **One example of the effect of stock pollutants is the numerous fish consumption advisories due to mercury contamination of fish.**
- **Medicinal waste is a more recent worry as drugs such as birth control and antidepressants have been found in fish tissue.**
- **These accumulating pollutants are extremely problematic because they are difficult to monitor.**
- **Persistent pollutants are pollutants that accumulate because they break down so slowly that they can travel long distances in water without changing structure.**

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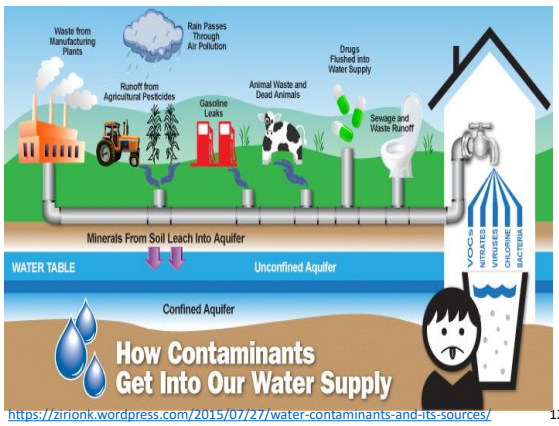


https://zirionk.wordpress.com/2015/07/27/water-contaminants-and-its-sources/

12

12

Some Example of Traditional Water Pollution Control Policy in the USA

- The Water Quality Act of 1965 set ambient water quality standards for interstate watercourses. States were required to file implementation plans.
- The Clean Water Act of 1965 sets out two goals: "that the discharge of pollutants into navigable waters be eliminated by 1985"; and "that wherever attainable, an interim goal of water be achieved by June 1, 1983."
- The 1972 Amendments to the Clean Water Act set two stages for meeting the standards.
- The 1977 Amendments to the Clean Water Act distinguished between conventional and toxic pollutants.

13

13

Traditional Water Pollution Control Policy

- Nonpoint Sources
  - Nonpoint source pollution control was not covered by the Clean Water Act. This type of pollution was seen as a state responsibility.
  - The reauthorization of the Clean Water Act in 1987 provided funding for a program to help states control runoff, but the states held responsibility for nonpoint source pollution control.
- The TMDL Program
  - A Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water-quality standards as well as an allocation of that amount to the pollutant's resources.
  - Since the late 1980s efforts focused on nonpoint sources. Voluntary programs and cost-sharing programs with landowners are the most common tools.

14

14

Traditional Water Pollution Control Policy

- The Safe Drinking Water Act
  - The Safe Drinking Water Act of 1974 provides more stringent standards for drinking water.
  - The primary regulations set maximum allowable concentrations for bacteria, turbidity, and chemical contaminants.
  - Secondary standards for odor and aesthetics were also set. Approximately 60,000 public water systems are subject to these standards.

15

15

Traditional Water Pollution Control Policy

- Ocean Pollution
  - Oil Spills
    - The Clean Water Act prohibits discharges of "harmful quantities" of oil into navigable waters.
  - Ocean Dumping
    - It is covered by the Marine Protection Research and Sanctuaries Act of 1972.
  - Ocean Trash
    - Few laws governing ocean trash except for explicit dumping.

Looking at Some Data

Maps and Statistics Ocean Pollution

Marine and Ocean Pollution Statistics and Facts 2020

16

16

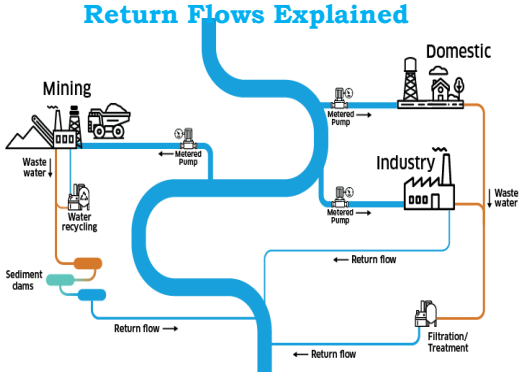
Efficiency and Cost-Effectiveness

- The efficient allocation of uncontaminated water requires marginal benefits to be equalized across all uses. However, if return flows are contaminated, this can alter the efficient allocation.
- The figure on the next slide demonstrates the effect of return flow contamination on the efficient allocation in the case of two users: an upper basin user and a downstream lower basin user.

17

17

Return Flows Explained



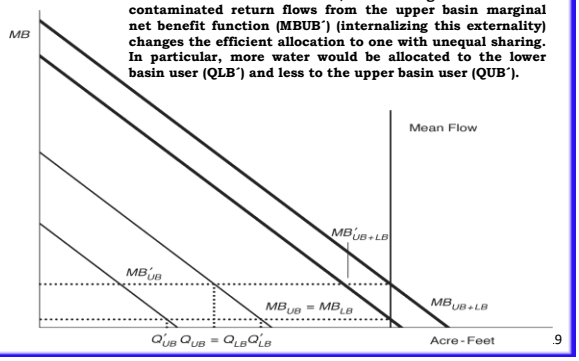
https://www.mdba.gov.au/managing-water/return-flows

18

18

Economic Efficiency When Return Flows are Contaminated

If the two users have identical marginal net benefits for uncontaminated water, the two users should receive equal amounts of water. However, subtracting the effect of contaminated return flows from the upper basin marginal net benefit function (MBUB´) (internalizing this externality) changes the efficient allocation to one with unequal sharing. In particular, more water would be allocated to the lower basin user (QLB´) and less to the upper basin user (QUB´).



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19

Efficiency and Cost-Effectiveness

Ambient Standards and the Zero-Discharge Goal

- The shift from ambient standards to a zero discharge goal was problematic.
  - The feasibility of meeting such a goal is small and thus enforcement is a problem.
  - For some pollutants, such a high cost might be justified. However, the zero discharge goal does not distinguish among pollutant types.

20

20

Efficiency and Cost-Effectiveness

National Effluent Standards

- **Enforcement Problems**
  - **Cost-effectiveness would require individual standards for each source, but the EPA chose general standards for broad categories of sources.**
- **Allocating Control Responsibility**
  - **Studies have shown that uniform standards do not closely approximate the least-cost allocation.**

21

21

Efficiency and Cost-Effectiveness

Municipal Waste Treatment Subsidies

- **The Allocation of Funds**
  - **States are now required to establish project priorities and target funds to the most significant needs.**
- **Operation and Maintenance**
  - **Operation and maintenance costs would be paid by the municipality. This type of program provides incentives to build expensive plants.**
  - **States are now required to establish project priorities and target funds to the most significant needs.**
- **Capital Costs**
  - **Local areas need to be more careful with capital costs.**

22

22

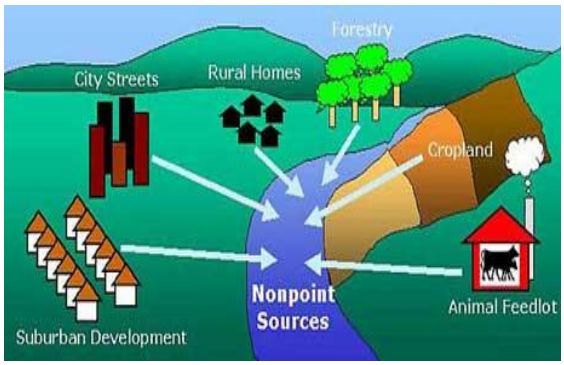
Efficiency and Cost-Effectiveness

- **Pretreatment Standards - regulate the quality of wastewater flowing into the waste treatment plants.**
- **Point Source Pollution - any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack.**
- **Nonpoint Source Pollution**
  - **Nonpoint source pollution has become a significant part of the total water quality problem.**
  - **More intensive controls have been placed on point sources as an attempt to compensate for nonpoint sources.**
  - **Studies suggest that some nonpoint sources could be controlled at low costs, especially with policies aimed at reducing nitrogen use.**

23

23

More Nonpoint Source Pollution Examples



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24

Efficiency and Cost-Effectiveness

Watershed-Based Trading

- **Trading for water pollution control involves point source polluters meeting water quality standards by purchasing reductions from other sources with lower marginal abatement cost.**
- **The trading program can bring large economic benefits from cheaper and faster clean up.**

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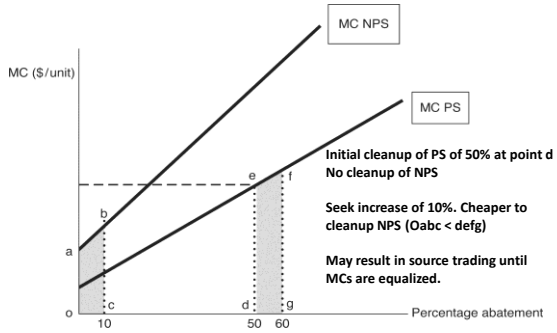
Potential Cost Savings with Trading across Point and Nonpoint Sources



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26

Efficiency and Cost-Effectiveness

Water Quality, Watershed-Based Trading, and GIS

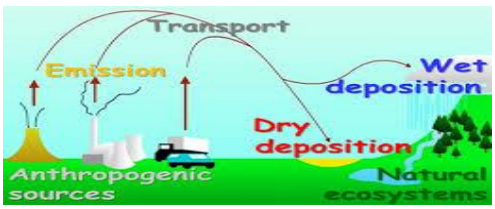
- **Land use change significantly affects watershed health. Agricultural and urban runoff into rivers, streams, and estuaries is the largest contributor to water pollution.**
- **Digital land use maps can be used to examine the relationship between land use and water quality.**

27

27

Efficiency and Cost-Effectiveness

- **Atmospheric Deposition of Pollution**
  - **Wet deposition refers to pollutants that travel to the ground with rainfall.**
  - **Dry deposition occurs when pollutants become too heavy and fall to the ground.**



https://www.srs.fs.usda.gov/airqualityportal/critical_loads/atmospheric_deposition.php

28

28

Efficiency and Cost-Effectiveness

- The European Experience
  - In Europe, economic incentives such as effluent charges play a much larger role.
- Developing Country Experience
  - Noncompliance and lack of infrastructure has hampered many water pollution control programs.
  - Water pollution is complicated by poverty.

29

29

Efficiency and Cost-Effectiveness

Oil Spills—Tankers and Off-shore Drilling

- Legal solutions have very high administrative costs and take enormous amounts of time.
- Vessel owners will choose the level of precaution that equates the marginal cost of additional precaution with the marginal expected penalty

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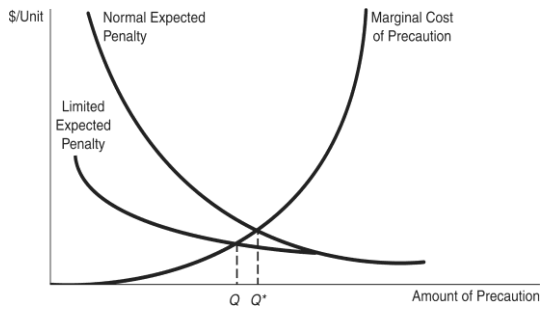
Oil Spill Liability



31

31

Efficiency and Cost-Effectiveness

An Overall Assessment

- The use of cost-effective policies would reduce costs substantially while not affecting the benefits.
- Economic incentives would also facilitate change better than technology-based standards that are rigid.
- The possibilities of using marketable permits for water pollution control are being explored for many bodies of water in the U.S.
- Economic incentives put pressure on sources to find better ways to control pollution.

32

32