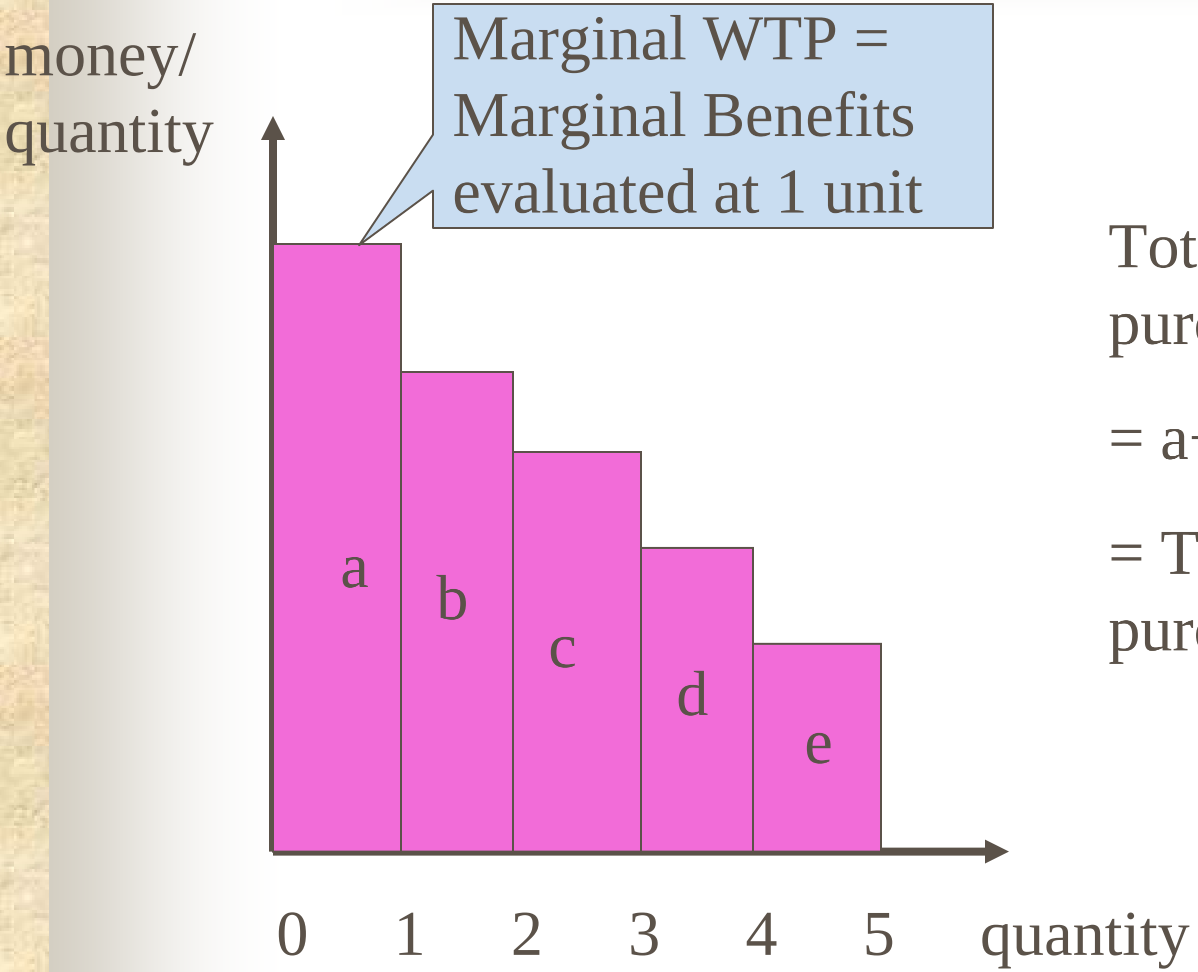
Fundamentals of the Economic Approach

Manabu Kondo
Shiga University

Willingness To Pay

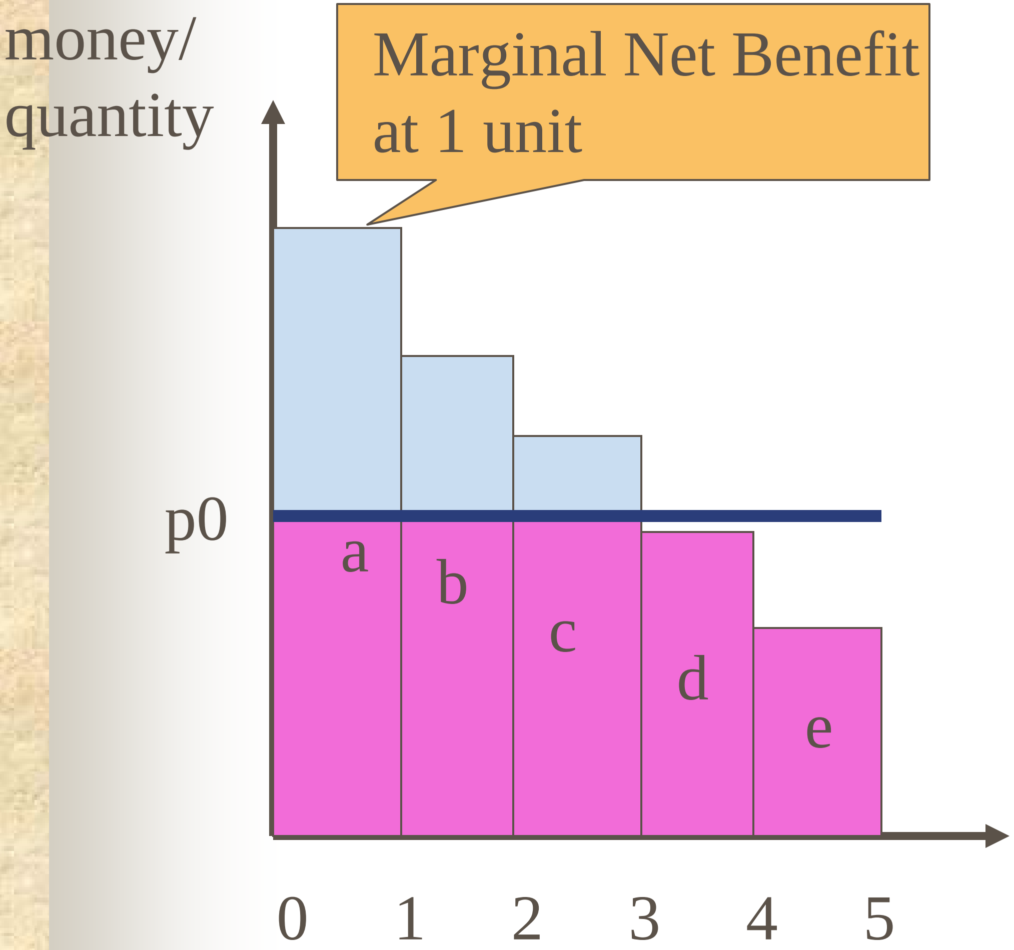
- (Definition) The amount of money it is considered that may pay in order to get some goods (or service or state of environment) by a certain person.
- Marginal WTP: the amount of money it is considered that may pay when purchasing one more unit of goods
- Total WTP: The amount of money it is summed up from marginal WTP evaluated at quantity zero to marginal WTP evaluated at quantity q0. When purchasing the goods of q0, it means the amount of money considered that a certain person may pay, i.e., the benefits which goods of q0 could bring about to a certain person.



Total WTP when purchasing 5 units

= a+b+c+d+e

= Total Benefits when purchasing 5 units



When market price is in p0, she may purchase 3 units of good.

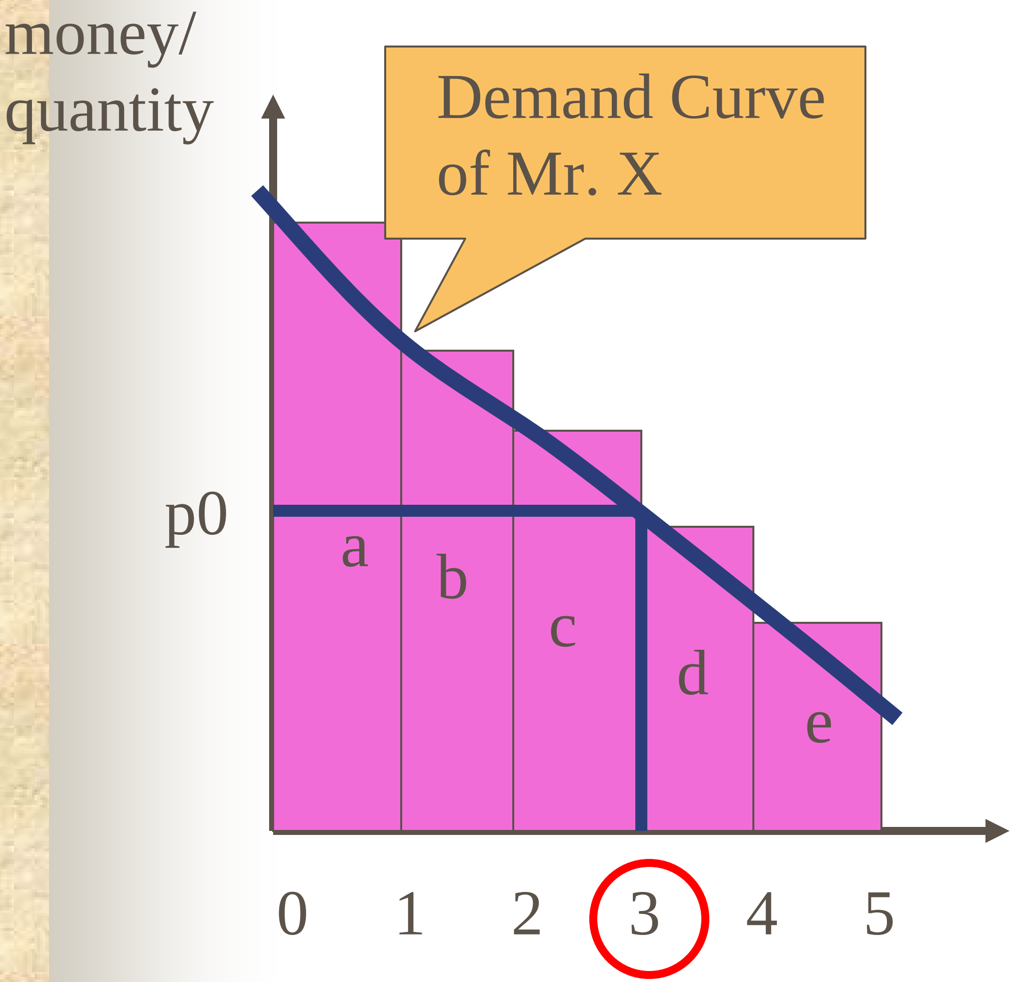
Because Marginal WTP evaluated at 3 (=c)> p0, so she can get net benefit from purchasing one more unit over 2.

Total WTP when purchasing 3 units = a+b+c

Cost = p0*3

Total Net Benefit = (a+b+c)-p0*3

Demand Curve



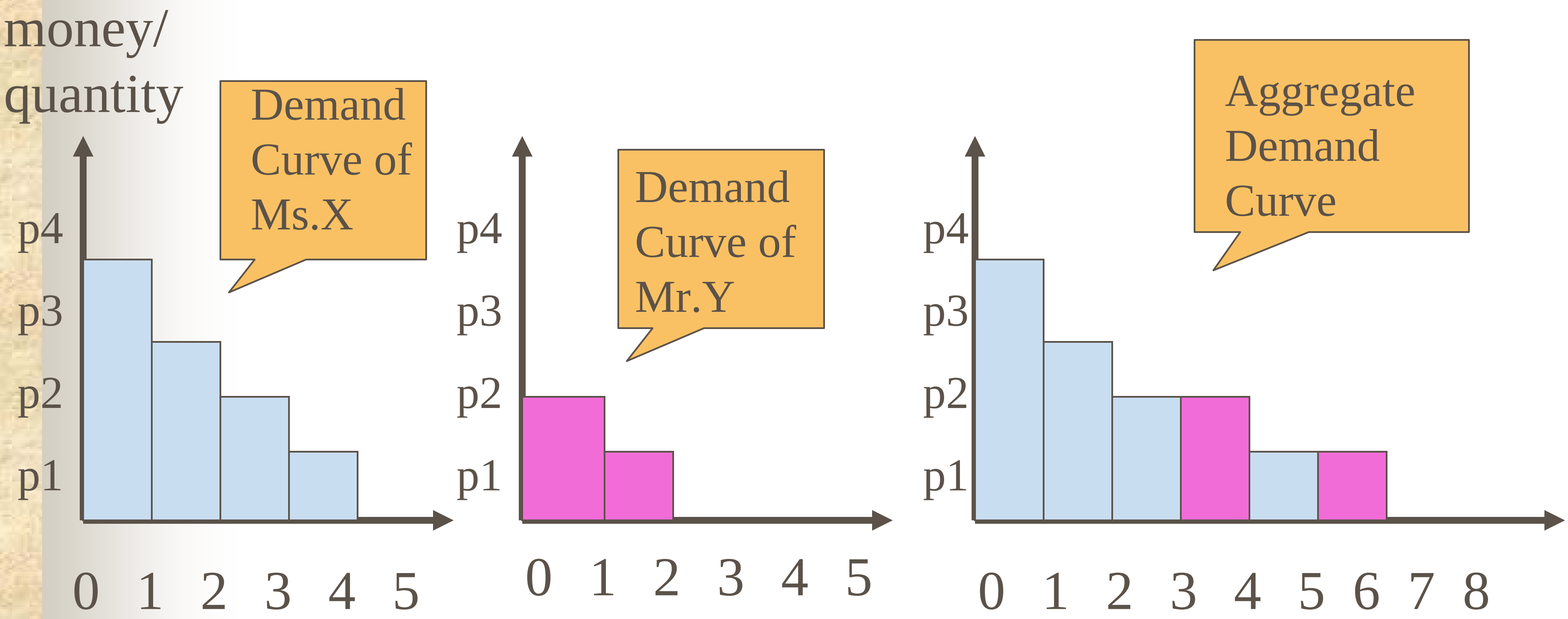
Demand Curve

= Marginal WTP Curve

= Marginal Benefits Curve

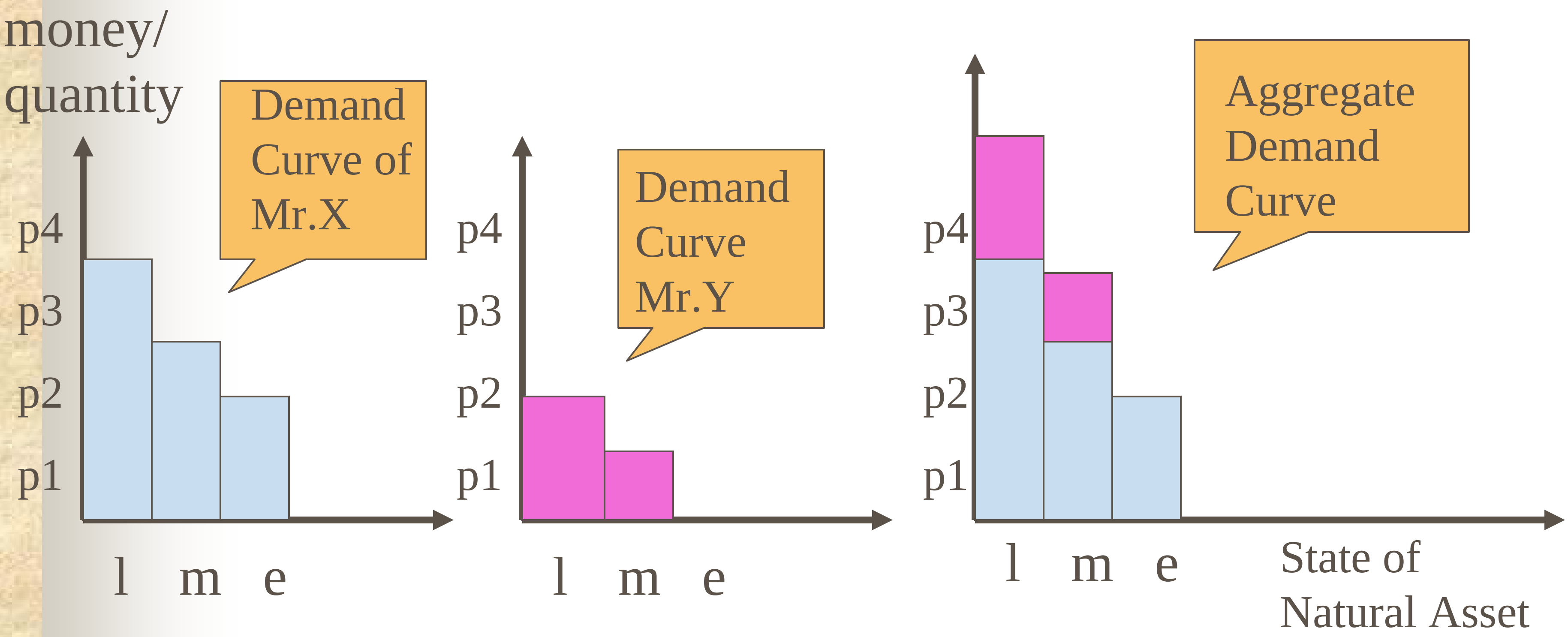
When market price is in p0, she will purchase 3 units of good.

Aggregate Demand for a Private Good



Adding individual demand curves horizontally

Aggregate Demand for a Public Good



l: Low level of Restration

m: Moderate Level of Restration

e: Extensive Level of Restration:

Adding individual demand curves vertically

External Cost, Social Cost

External Costs of Water Resource Development

- Although profits and benefits occur in water resource development, external cost is also generated inevitably.
- Social cost = private (user) cost + external cost
- External Costs of Water Resource Development:

---ecological damage and loss of biodiversity by dam construction

---aggravation of water quality, eutrophication

---scenic damage and tourist income reduction

---fall of water table, change of water flow

---reduction of sands flow for downstream, etc.

A Case Study of External Costs Estimated by US-EPA (1990)

Total Pollution Reduction Costs (TPRC) when the present Anti-Pollution Policies are carried out completely

	1972	1980	1990	2000
Total Pollution Reduction Costs (TPRC)	26,481	57,969	100,167	160,416
Ratio for GDP of TPRC (%)	0.88	1.58	2.14	2.83
[Distribution of TPRC]				
1.Air and radioactive pollution	30.1	30.7	28.0	28.0
2.Water pollution	37.4	42.7	42.3	40.0
3.Soil pollution	31.8	23.5	26.5	28.8
4.Chemical pollution	0.3	1.6	1.6	1.8
5.Multi-medium contamination	0.4	1.5	1.6	1.4

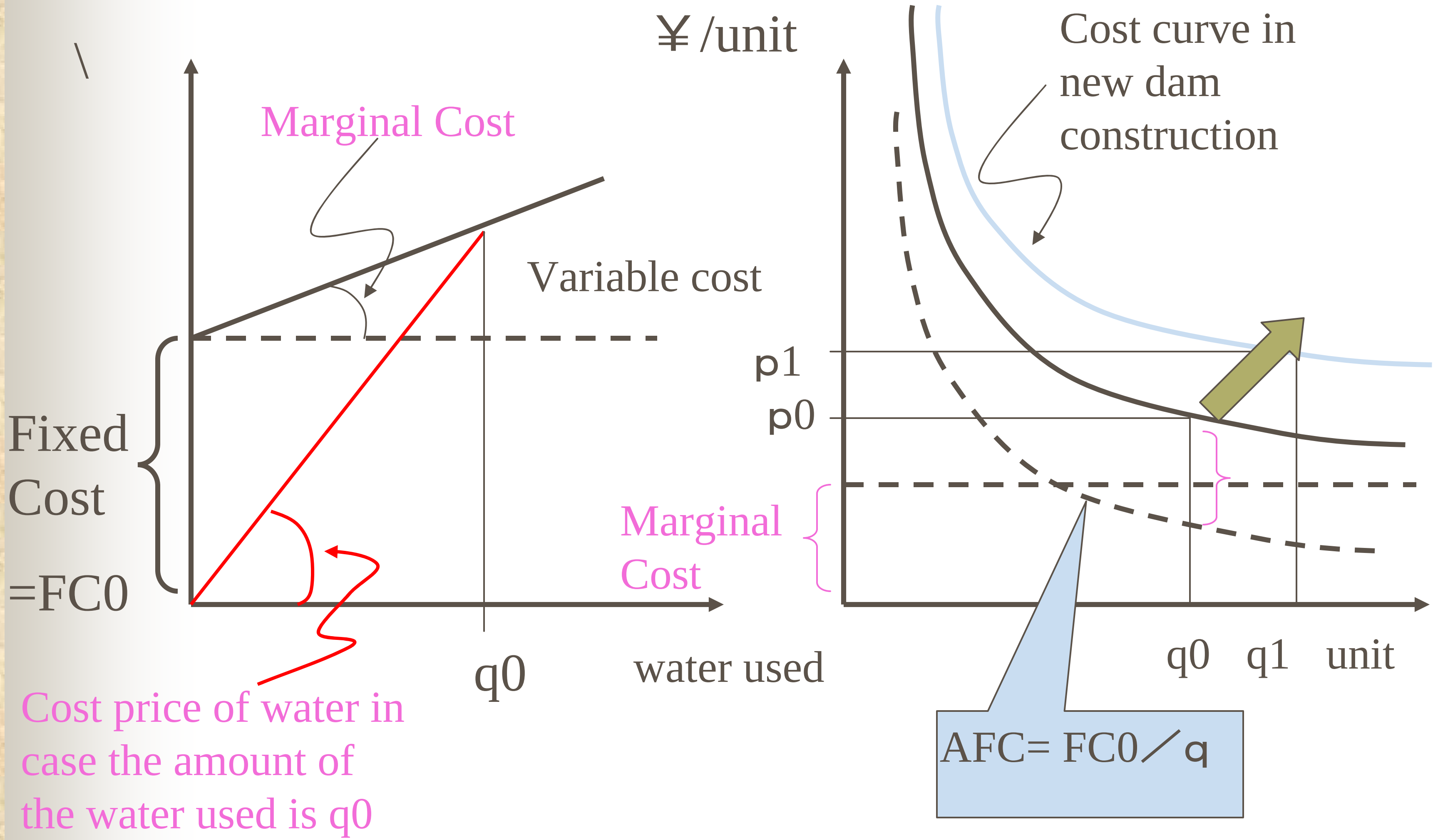
Note: The observation cost for regulation and the administrative cost for performing regulation are also included in TPRC.
Source: U.S. Environmental Protection Agency, *Environmental Instruments: The Costs of a Clean Environment*, EPA 230 12 (92-084), Washington, DC, 1990, pp.2-2～2-3.

Cost Price of Water

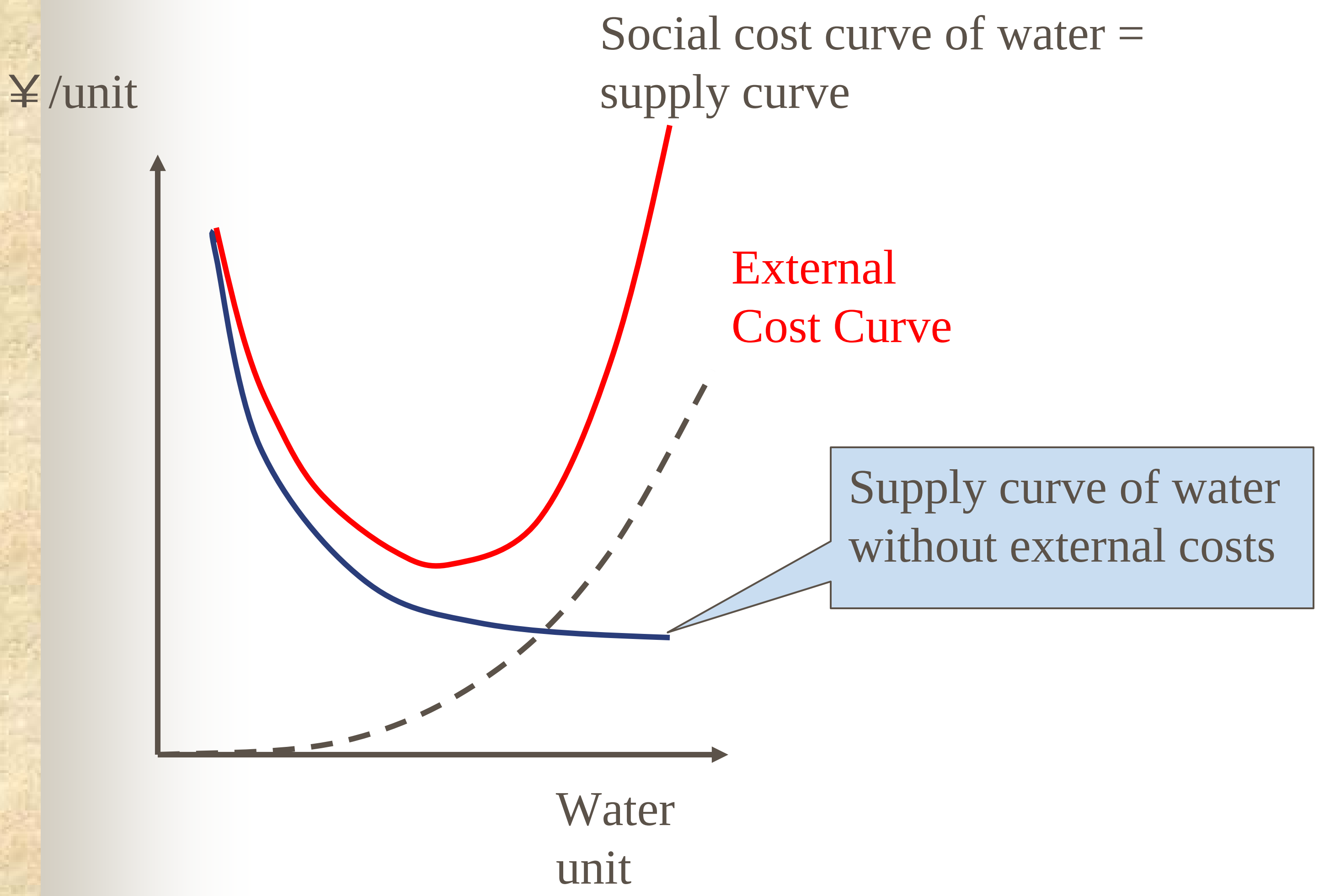
- (1) Fixed Cost---infrastructure cost such as dam, water quality purification station, reticulation system, furrows system, etc. Administrative expenses, a general maintenance cost
- (2) Variable Cost--- expense which is needed along with the increase in the water amount of supply. For example, Electric cost, labor cost, chemicals cost, etc.
- （3）Cost Price of Water = Fixed Cost + Variable Cost

Cost Price of Water: Total and Marginal

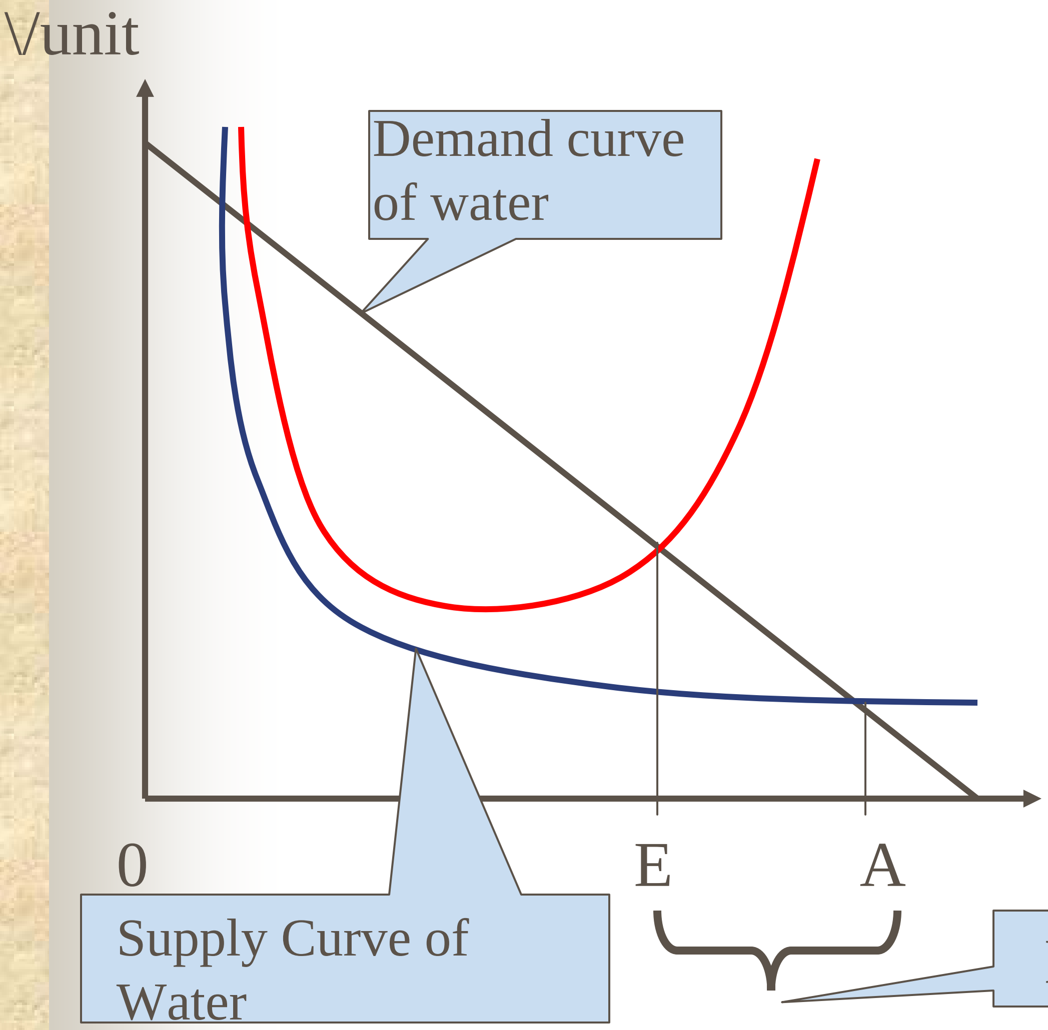
Cost price of water per unit= Average Fixed Cost + Marginal Cost



Supply curve of water (when there is no new dam construction)



The determination for water supplies: desirable level and actual level of water supplies



When not taking the external cost of water supply into consideration, water is used to the level of 0A.

The desirable level for water supplies is 0E socially.

Two Methods of Managing the Excess of Water

- Direct regulation ... defining the maximum of the amount of the water used and assigning it for every economic player.
→Irrationality of initial distribution
→High adjustment cost

- Inductive regulation by market-based management technique ...

(1) Subsidies or Tax

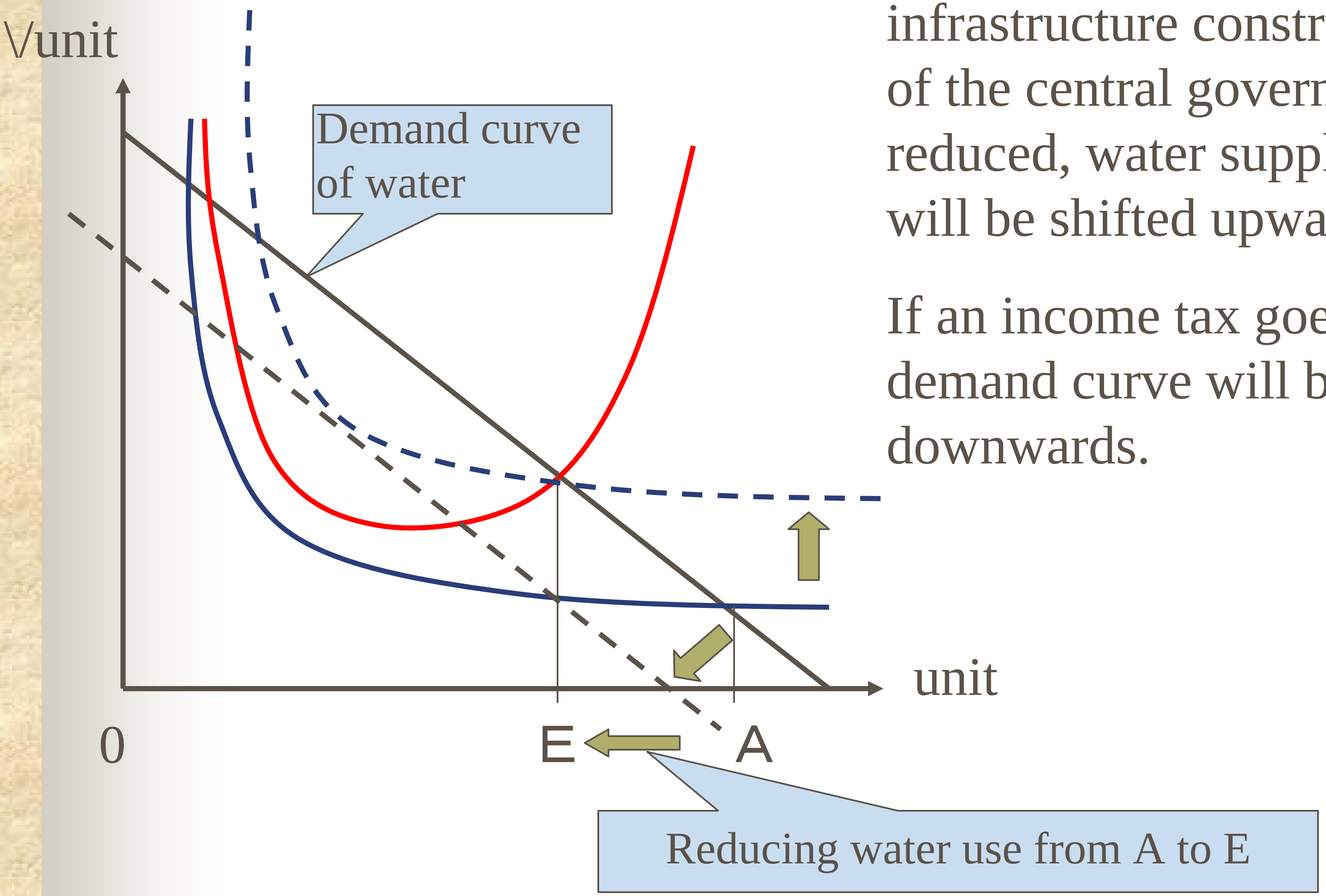
(2) Introduce a charged system and manage water demand.

(3) Creating water rights market and leaves it to market dealings.

Market-Based Policy Instruments and Management

(1) Subsidies or Tax

Effect of Subsidy and Income Tax

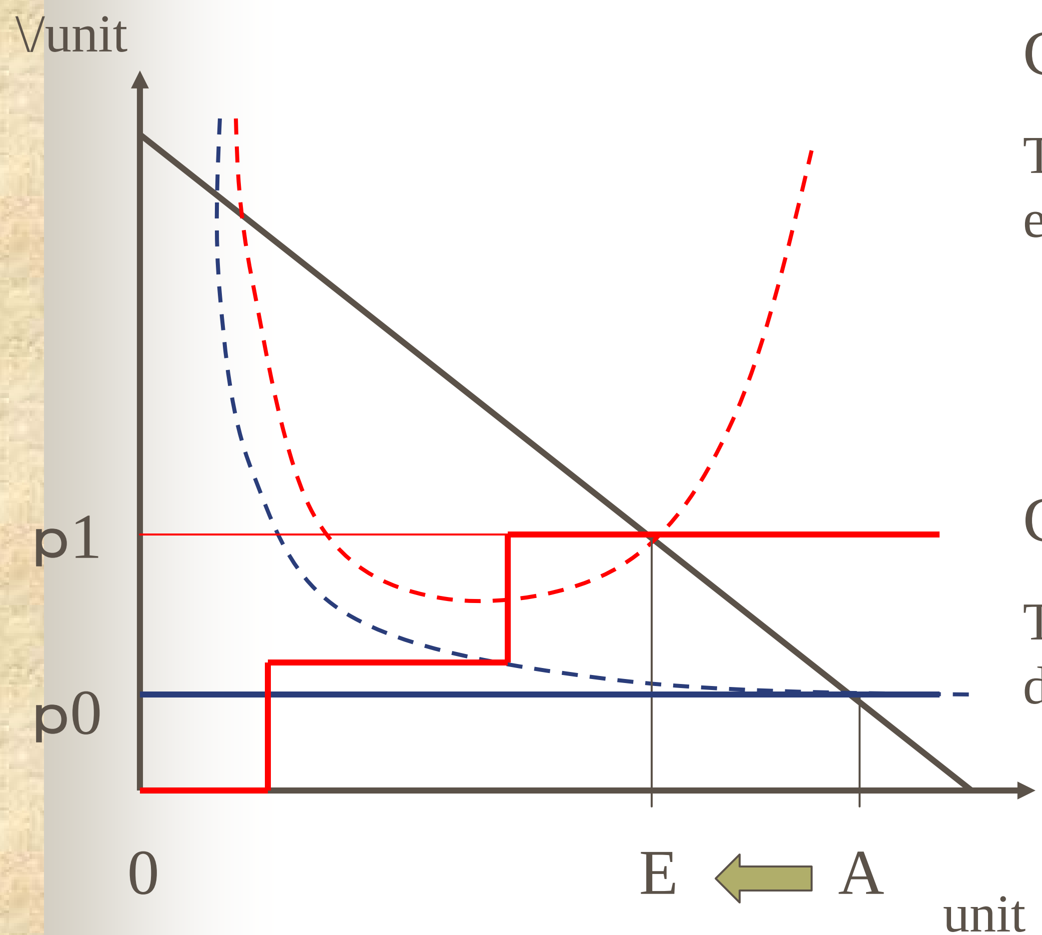


If the subsidy to infrastructure construction of the central government is reduced, water supply curve will be shifted upwards.

If an income tax goes up, demand curve will be shifted downwards.

（2）Volumetric Charging and Increasing Block Rate Charging of Water

Volumetric Charging and Increasing Block Rate Charging



(1) Volumetric Charging ＝ Cost Price of Water＝p0

Total cost of water supply is ensured.

(2) Two Step Block Rate Charging＝ [0～p0～p1]

The water used can be reduce to a desirable level.

（3）Creating Water Rights Market

About Water Rights Trading

- Water rights: The right that can intake and use river water (or groundwater) up to the accepted maximum exclusively.
  In order to acquire new water rights, the burden of expenses, such as dam construction, is required.
  *Irrigation Farmer, Local Government, Company, etc. can become the owner of water right.

* In the case of the right to pass drainage to a river up to the accepted maximum, the right is called exhausted water rights.

- Water Rights Trading : Well defined water rights can be tradable when you want to sell or buy some amount of water like the usual commercial transaction.

Expected various pattern of water rights trading

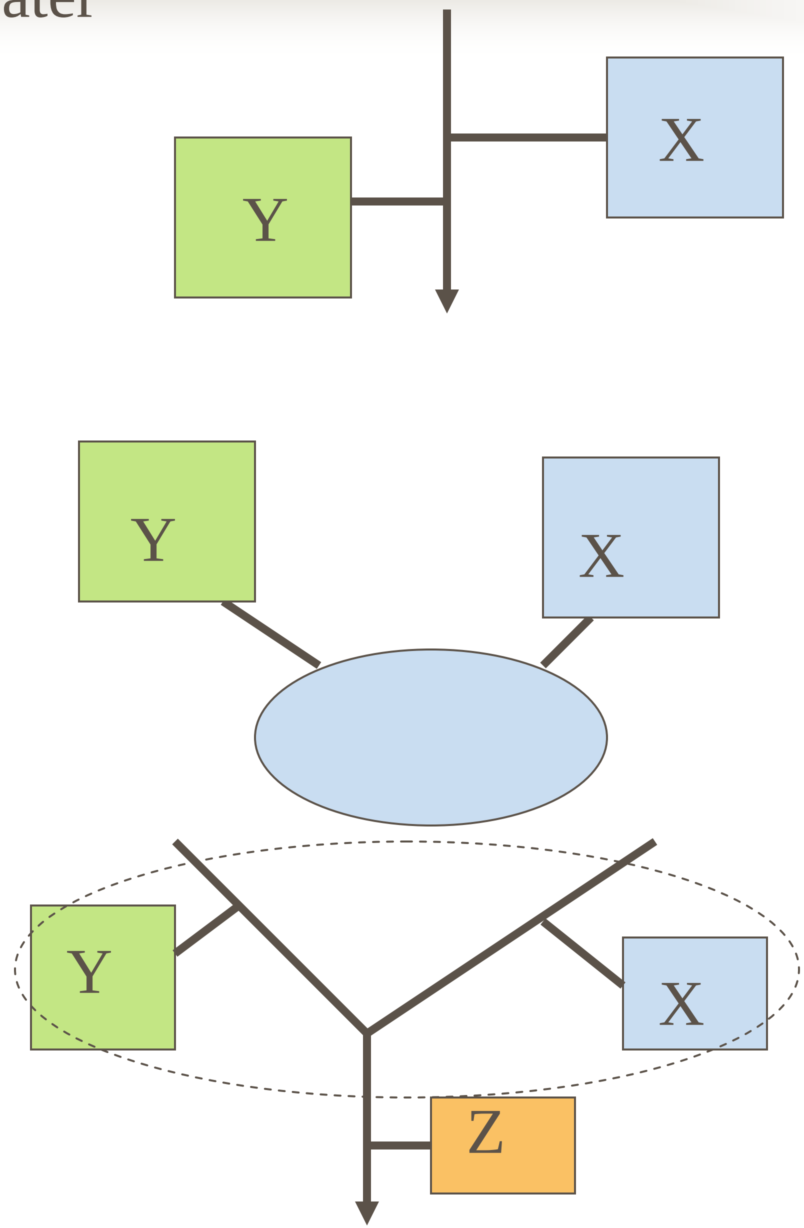
(1) irrigation farmer and irrigation damer

(2) local government and irrigation farmer

(3) local government and local government

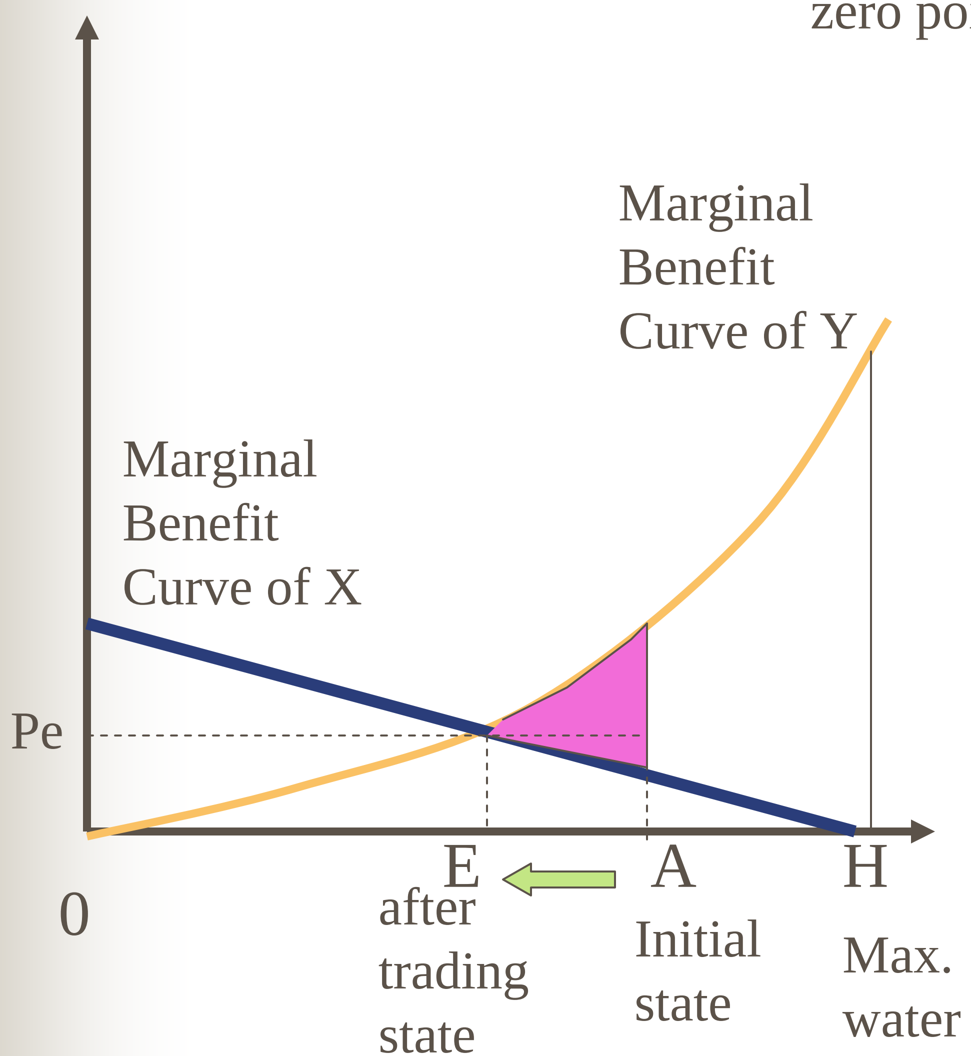
(4) local government and firm

(5) Upstream and downstream



Water Trading-Case 1

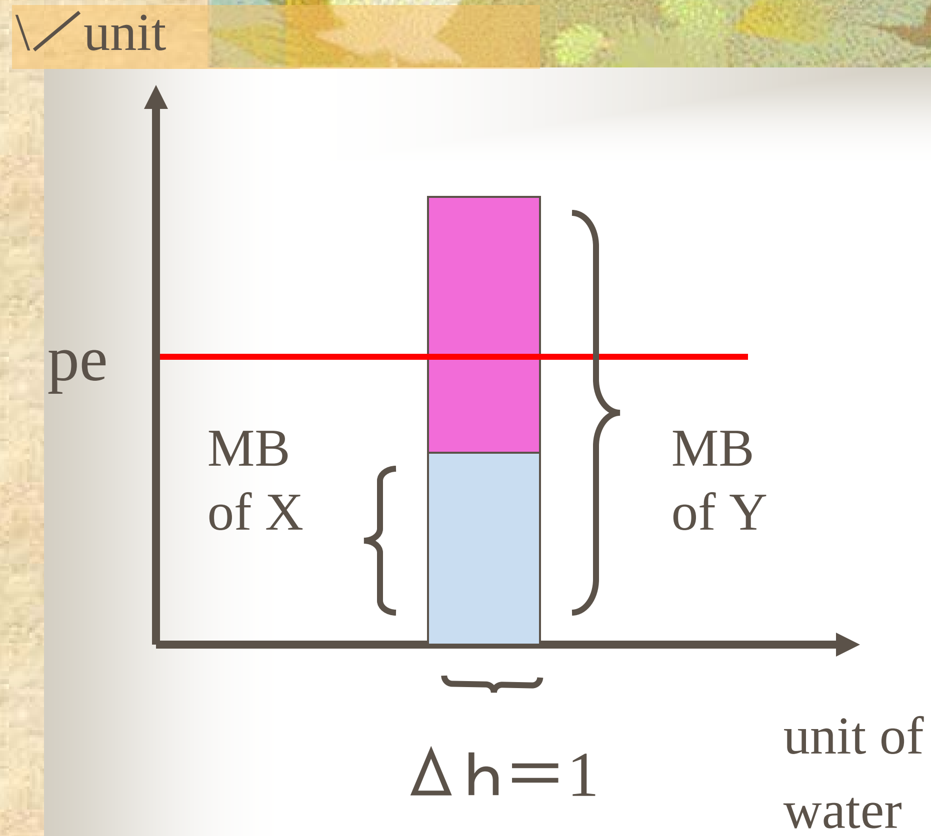
X : The water demand person who performs profit activity. A water amount demanded is measured rightward from zero point.



Y : The water demand person who performs another profit activity.A water amount is measured leftward from Point H.

If X sells off one unit to Y at pe, X can increase the marginal net benefit, and Y can also make a profit increase.

In this way, Social Net Benefits changes to the maximum at point E.



(1) Net Benefit of X selling off the water of one unit to Y

=Pe × 1 − MB of X × 1

= (Profit on sale) − (Opportunity Cost)

(2) Net Benefit of Y purchasing the water of one unit from X

=MB of Y × 1 − pe × 1

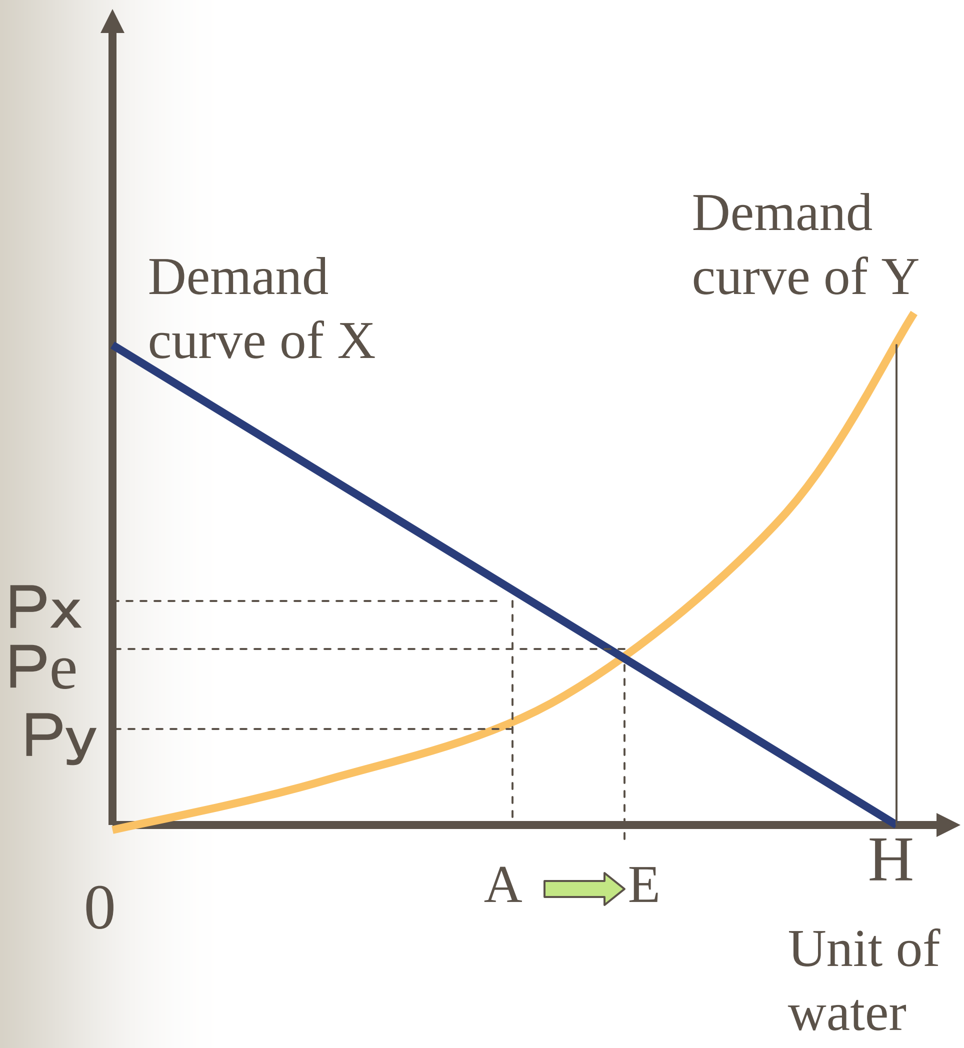
= (Profits by the increase of production) − (Purchase expense)

If the condition, MB of X <pe<MB of Y, is hold, both seller and buyer can be better off by water trading.

Water Trading-Case 2

X : Water Management Body of City X.

Y : Water Management Body of City Y



Px: water price of City X

Py: water price of City Y

Suppose that city X runs short of water and city Y is left by change of population.

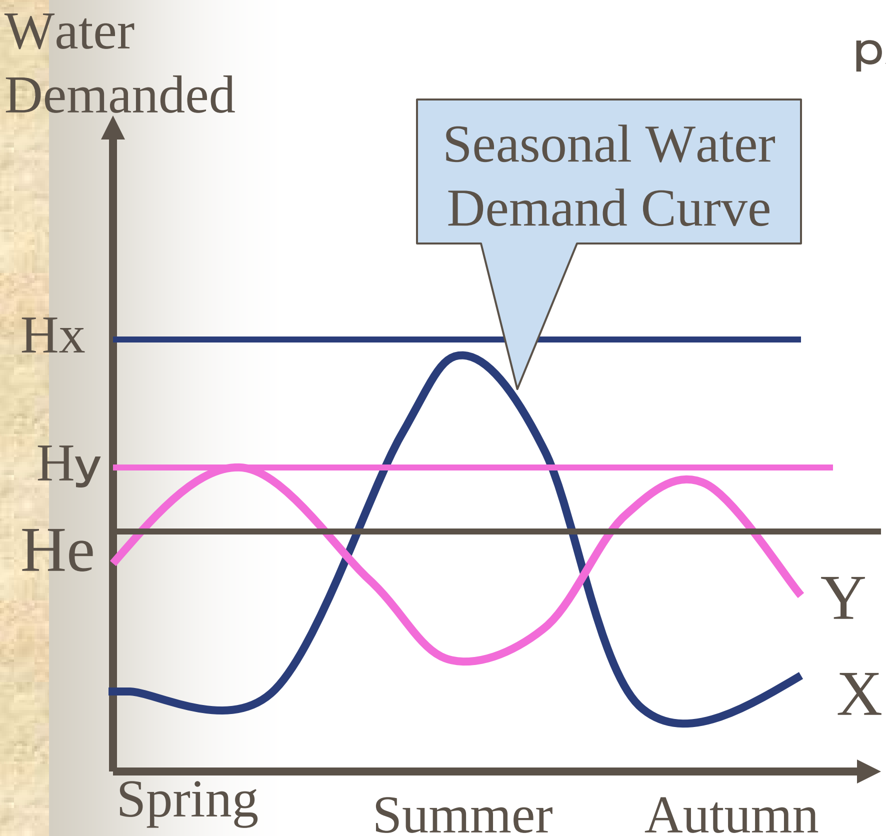
If there is a free trading market and X purchases water 1 unit from Y at Pe, then X can obtain net benefits of Px-Pe. Similarly Y can obtain the net benefits of Pe-Py.

Water Trading-Case 3

Hx : amounts of water rights of X

Hy : amounts of water rights of Y

px,py : expected water price of x and y



As for X, water is left in spring and autumn and, as for Y, water is left conversely in summer.

If the seasonal water fall and demand variation is stable, the amount of quota water rights of both X and Y is reducible to not Hx+Hy but He by founding a temporary water rights market.

Price condition:

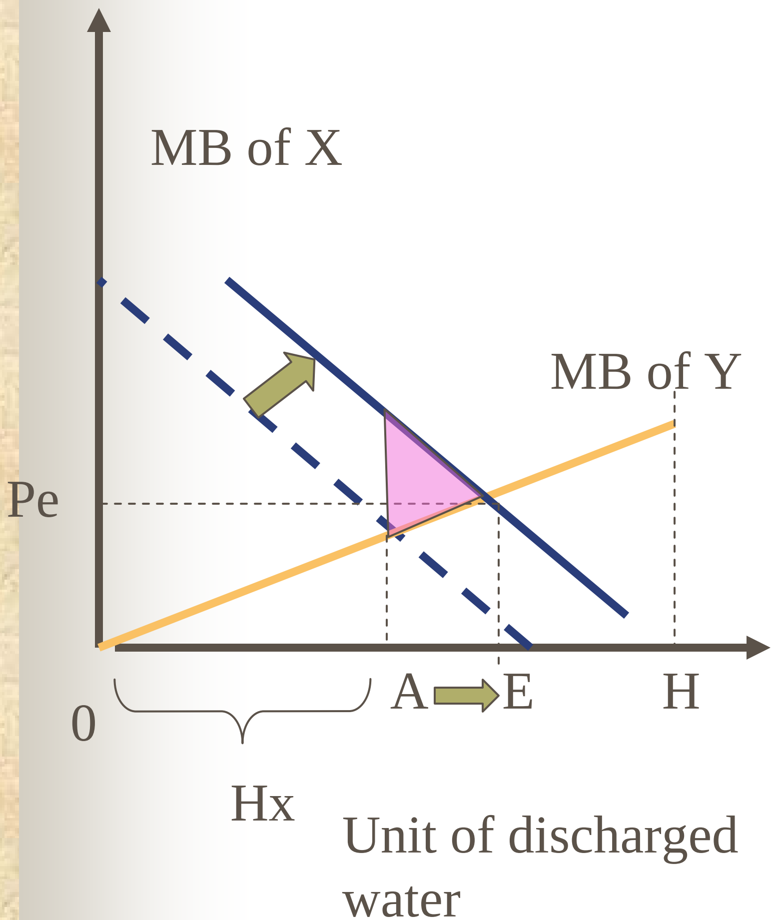
px<pe<py (in Spring & Autumn)

py<pe<px (in Summer)

Water Trading-Case 4 (emission permits trading)

Hx : Initial amount of discharge of the sewage in which X is permitted、Hy:Initial amount of discharge of the sewage in which Y is permitted

Hx+Hy=0H (=Max. amount of discharge)

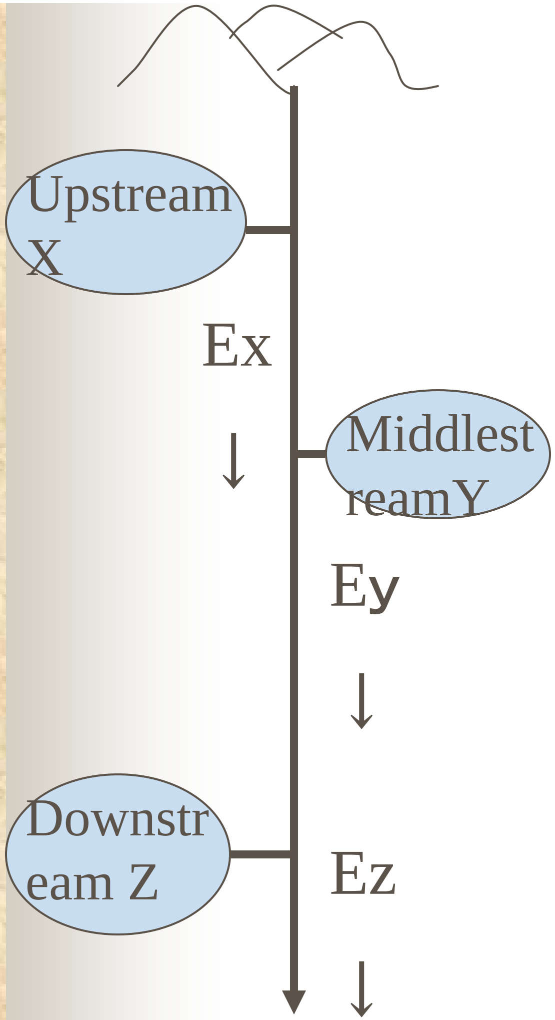


Suppose that the MB curve of X shifted up by technical progress, change of products, etc., then the allocation of point A become non-efficient economically.

If Point E is attained by emission trading, under the restriction of [MR of Y < pe < MB of X], the both sides will get net benefits, and social net benefits will serve as the maximum.

(4) Watershed Conservation Fees

Basin-Wide Optimization by using Watershed Conservation Fees (1)



When each area of X, Y, and Z attains optimization separately, it is best to make water distribution increase from the industry with highest marginal net benefit.

However, the upstream economic activities generates the external cost E to the lower stream. Therefore, total net benefits of sectoral-optimization （TNBa） will be:

$$TNBa=Bx+(By-Ex)+(Bz-Ex-Ey)-Ez.$$

On the other hand, total net benefits in Basin-Wide Optimization case（TNBb）will be:

$$TNBb=(Bx'-Ex')+(By'-Ey')+(Bz'-Ez')$$

Basin-Wide Optimization by using Watershed Conservation Fees (2)

If it assumes that (Bx+By+Bz)= (Bx'+By'+Bz') is hold, then,

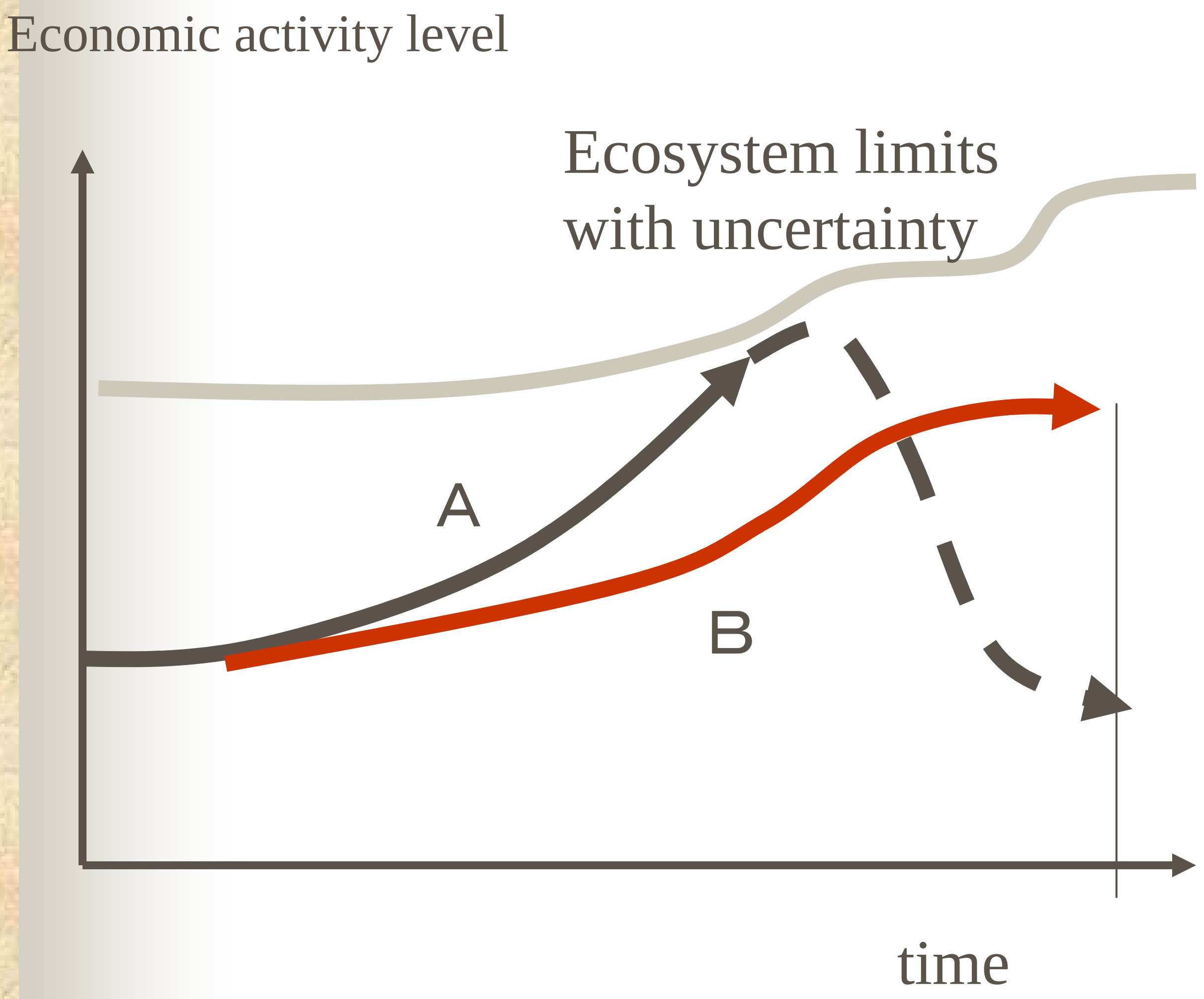
under the restriction of [2 Ex+Ey+Ez> Ex'+Ey'+Ez'], the TNBb could be greater than TNBa. This means that External Cost reduction is more effective for maximization than economic development in this case.

For example, if Watershed Conservation tax is introduced in the basin level and this income is used for upstream forest conservation to reduce external cost and/or is used for promotion of green industry (for example, agriculture, sightseeing), the bigger Total Net Benefits can be realized.

Cost changes to Benefit. Benefit changes to Cost.

(5) Slow Economic Growth Management

Temporary Optimization and Long-Term Optimization



Slow Economy is faster than Fast Economy.

Path B can make more economical output than path A in the long run.

Slow economic growth management is rational from the viewpoint of Precautionary Principle.

Comments on the Market-Based Management Policy in Japan

(1) Water demand is controllable.
Moreover, introduction of the charged system of water promotes efficient use and recycling of water. Charging of groundwater should be considered.

(2) In Japan, the approach of bringing water supply close to water demand was in use until now.However, such an approach should be converted.
In order to manage water demand from now on, introduction and practical use of the market-based management policy are desired.

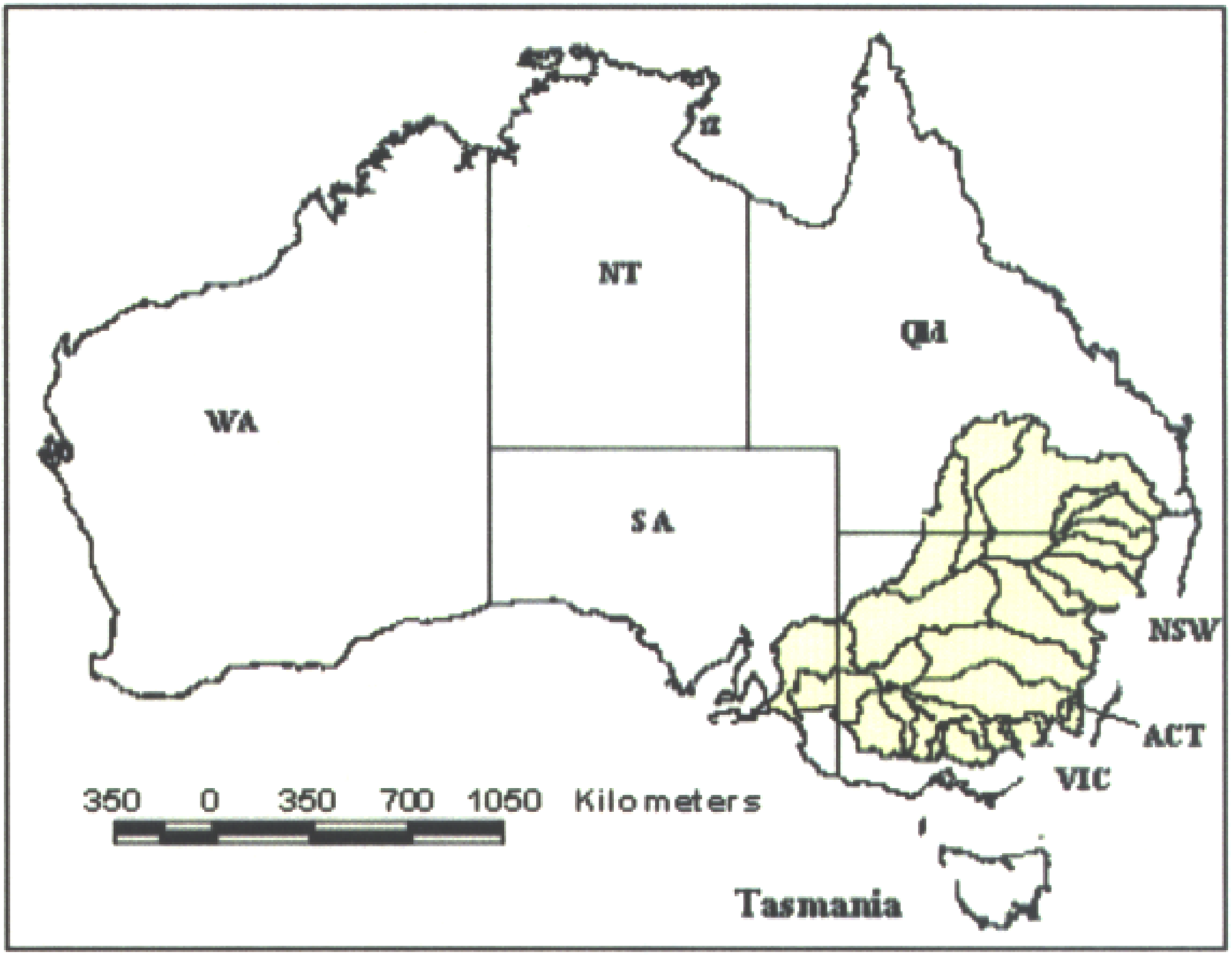
(3)The Cost-Benefits Ratio of water supply was ambiguous as a result of “soft budget constraint”.

Case Studies

Examples of Water Rights Market

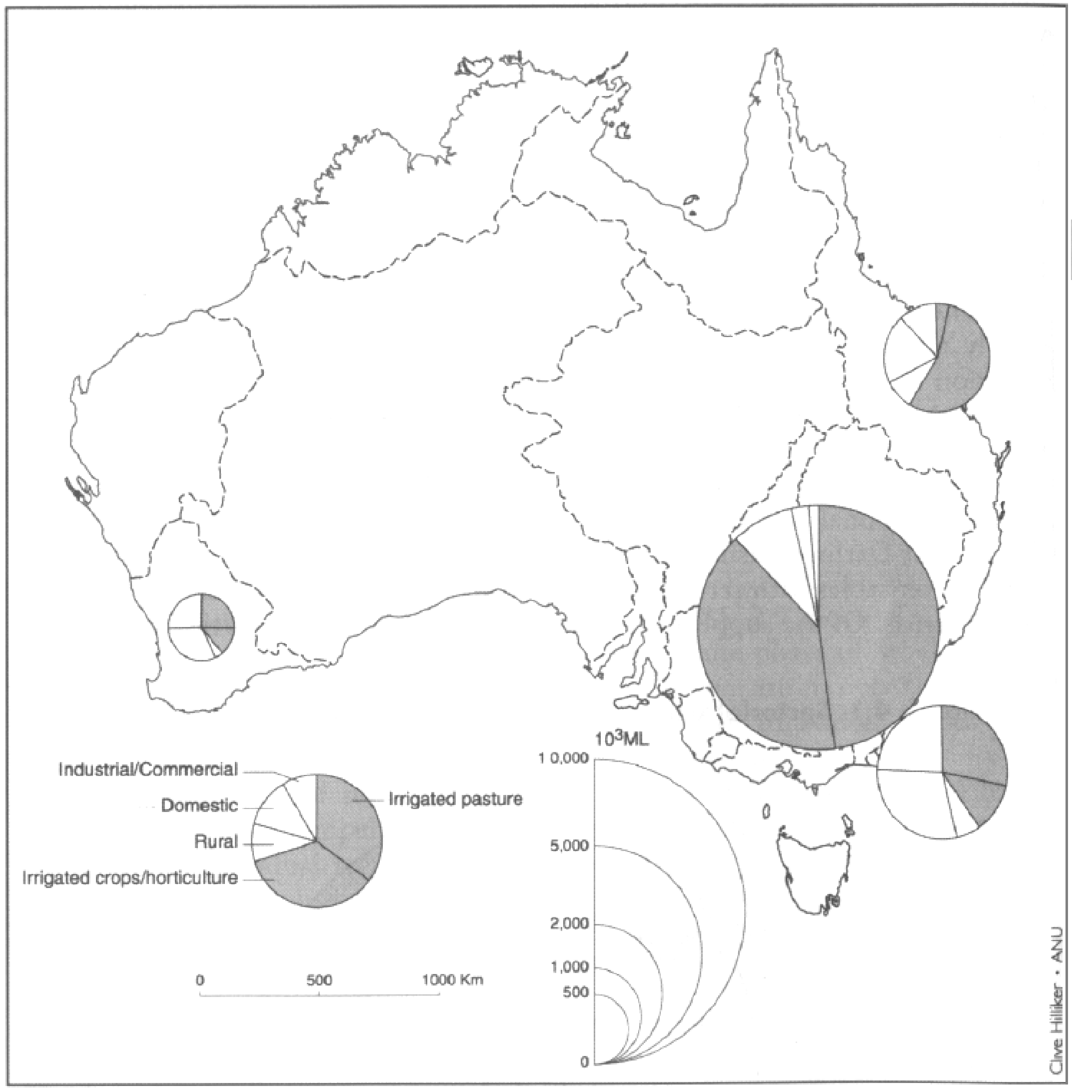
- WRM carries out in United States, Australia, the Netherlands, Brazil, Spain, and Chile at present.
- Introduction of WRM is under examination in China, Tanzania and so on.
- Executive Organization of Basin Management: Murray-Darling Basin Commission, and introduction of CAP system, inter-state trading
- "Environment flow" by a civic donation through WRM
- Appearance of Internet Water Rights Market and Water Broker

Map of Australia with State Lines and the Outline of the Murray-Darling Basin

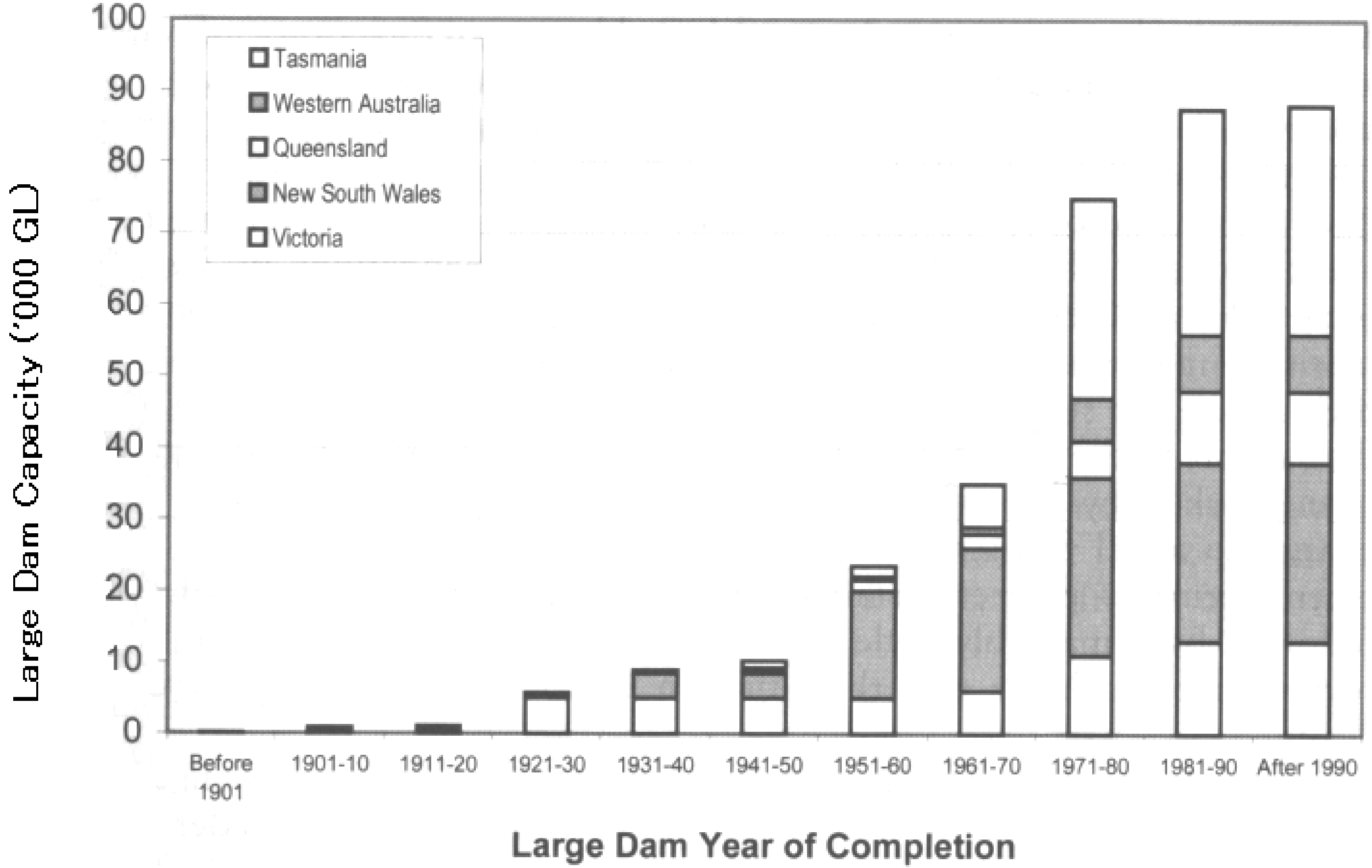


Source: MacDonald and Young(2001), p.8.

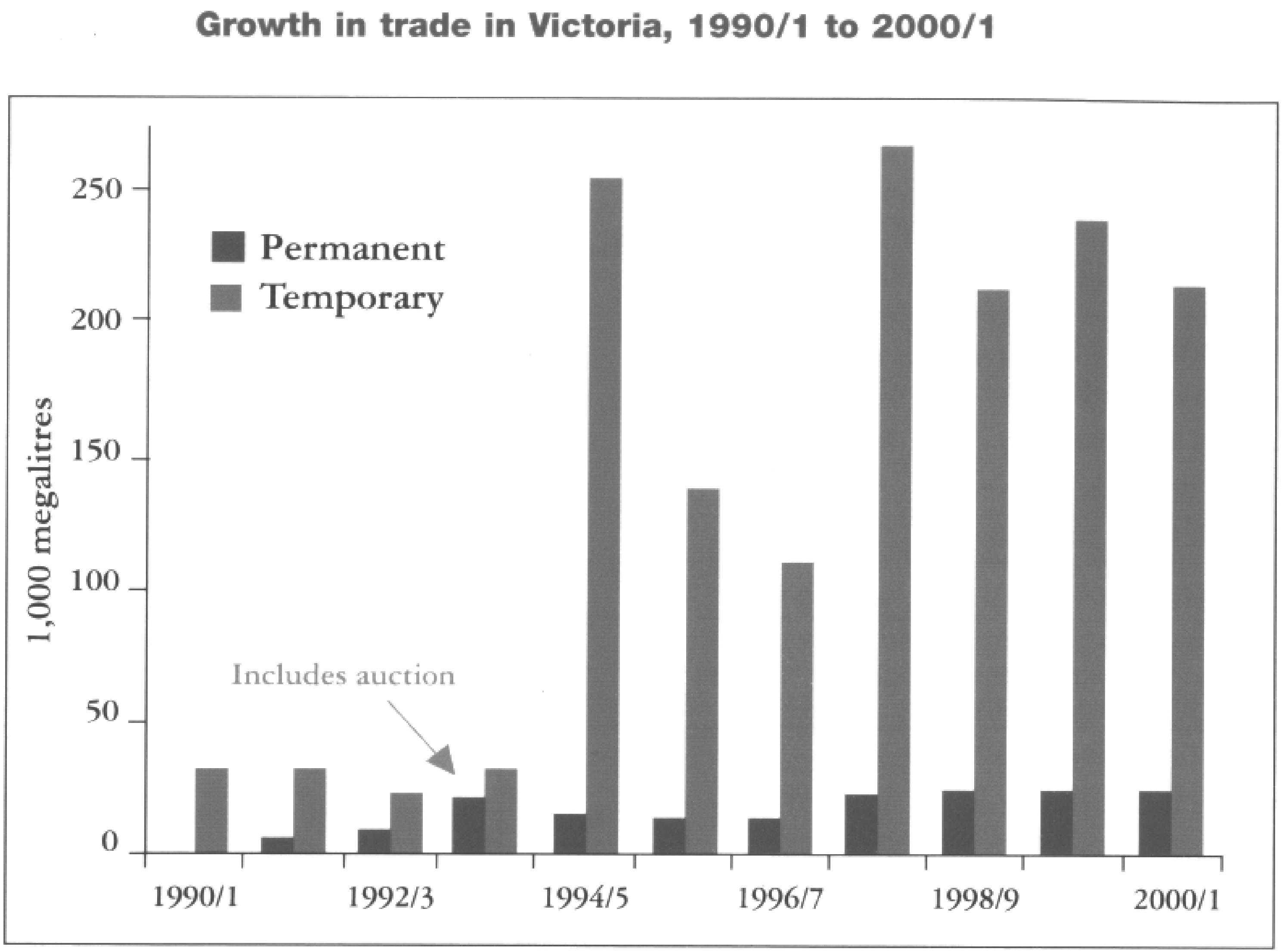
Spatial and sectoral use of water in Australia (from Smith 1998a)



Source: Smith(2003), p.56.

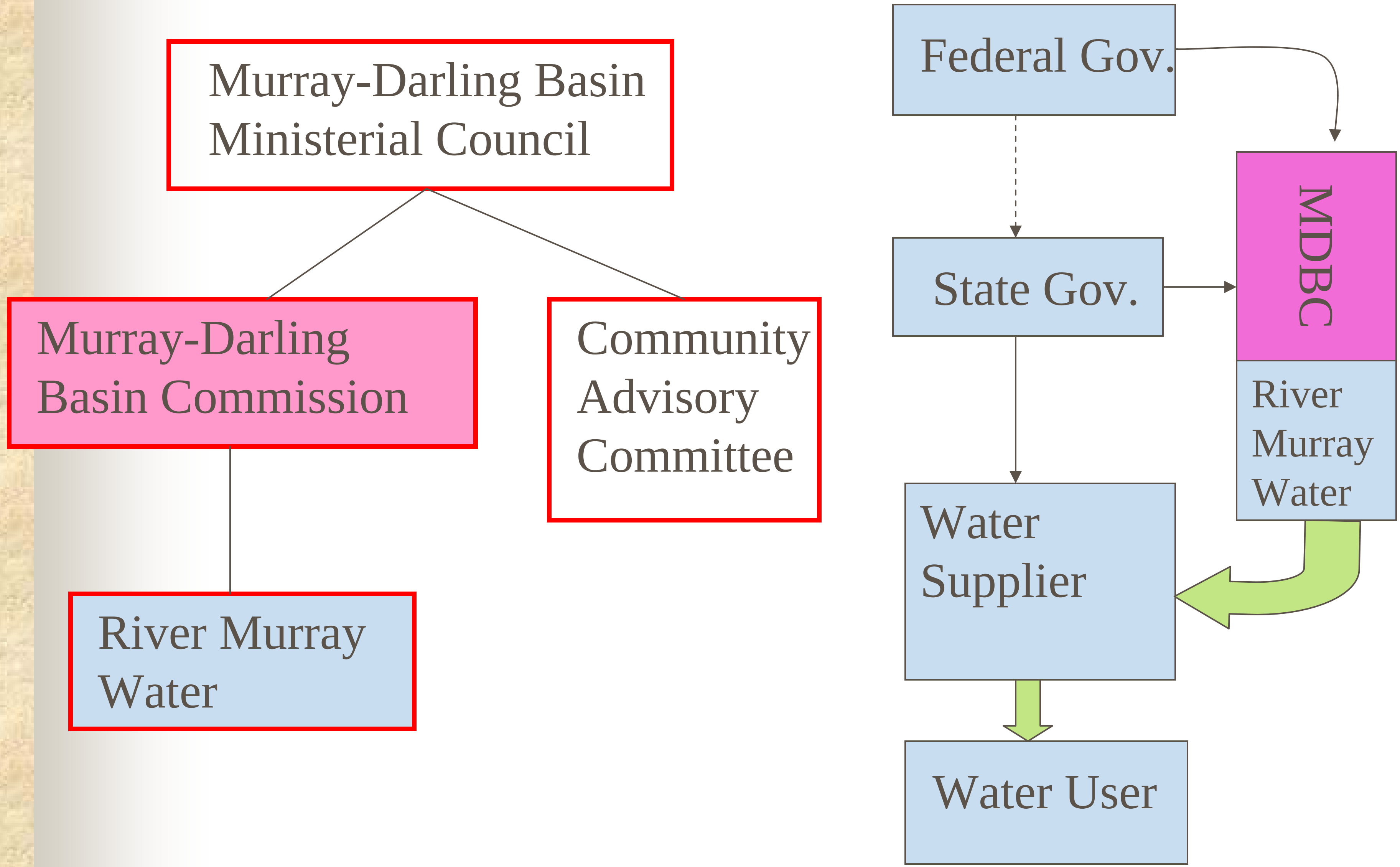


Source: Smith(2003), p.59.



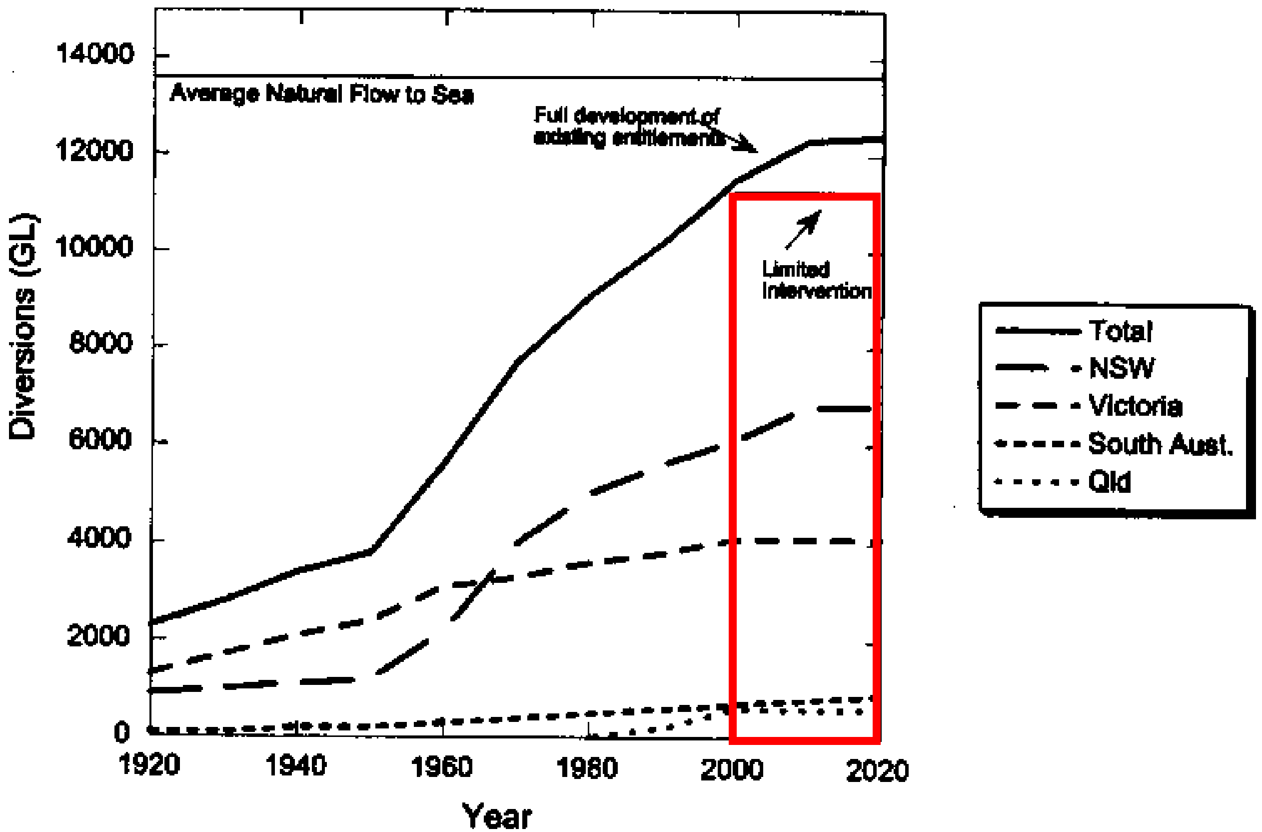
Source: Department of Natural Resources and Environment (Victoria)(2001), p.12.

Organizational chart of MDBC



CAP system in Murray-Darling Basin

（introduced in 1997 everlastingly based on a standard in 1994.）



Annual diversions from the Murray–Darling Basin 1920–95 with projections to 2020

Source: Murray–Darling Basin Commission (2000)

References

- MacDonald, D.H., and Young, M., 2001, *A case study of the Murray-Darling Basin: Final Report for the International Water Management Institute*, Policy and Economic Research Unit of CSIRO Land and Water, Adelaide.
- Smith, D.I., 1998, *Water in Australia: resources and management*, New York: Oxford University Press.
- Department of Natural Resources and Environment (Victoria), 2004, *The Value of Water: A Guide to Water Trading in Victoria*, DNRE, Melbourne.
- Murray-Darling Basin Commission: http://www.mdbc.gov.au/
- Dovers, S., and Wild River, S.(eds), 2003, *Managing Australia's Environment*, Sydney: The Federation Press.
- Field, B.C., 2001, *Natural Resource Economics: An Introduction*, The McGraw-Hill Companies, Inc.: New York.
- Kondo, M., 2006, Water Reform in Australia: its general overview, *Annual Report of Research Center for Sustainability and Environment*, No.3, pp.49-65, Shiga University: Hikone, Japan.