Material Flows Analysis on Construction Aggregates and Valley Pollutants in Taiwan

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- Results
  - Construction aggregates
  - Valley Pollutants
- Conclusions and Recommendations

Introduction

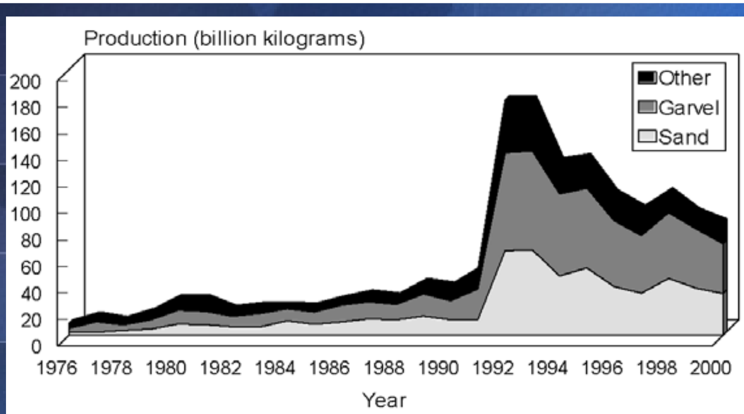
- Recent decades of economic and industrial development in Taiwan have accelerated the demand and use of construction aggregates and the accumulation of pollution .
- MFA was applied to research the flows on
  - construction aggregates in Taiwan.
  - the pollutants of Biological Oxygen Demand (BOD_5), Suspended Solids (SS) into the estuaries located on the northern and southern coasts of Taiwan (Tamsui river valley characterized by high human population density and Kaoping stream valley characterized by high levels of animal husbandry and heavy industry).

Purpose

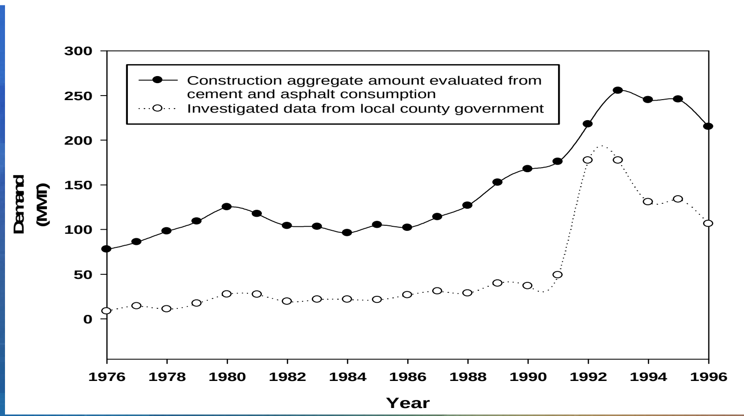
- To develop a construction aggregates and valley pollutants MFA and evaluated system for Taiwan.
- Help to develop various non-linear and dynamic simulation models for providing a reliable reference for Taiwanese government in its decision-making processes concerning the national dematerialization programs.

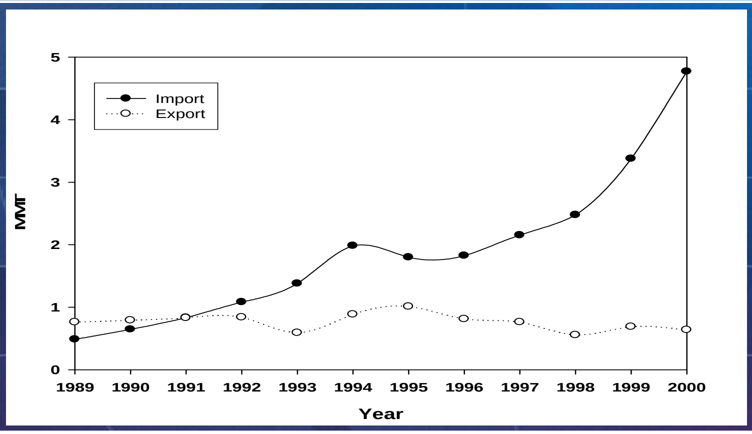
Results (Construction Aggregates)

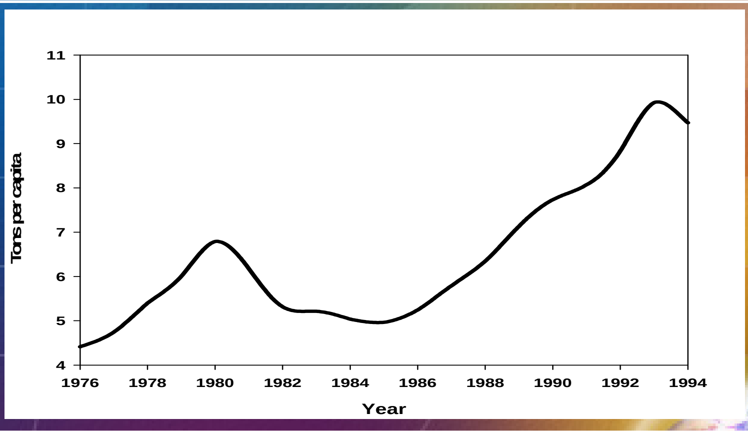
Domestic production



Demand





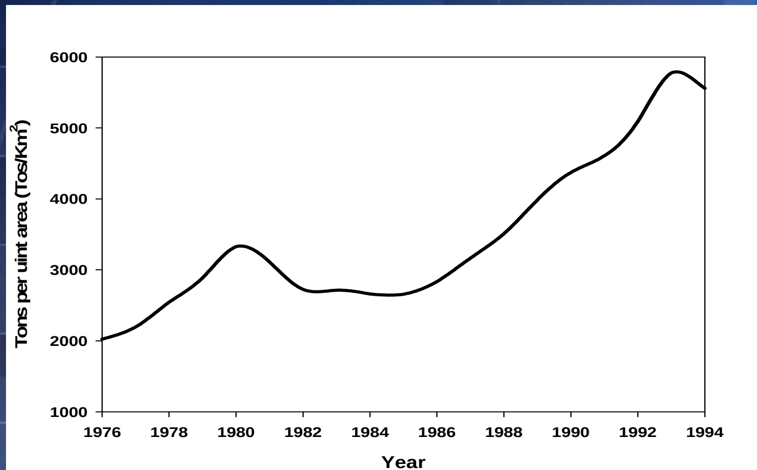


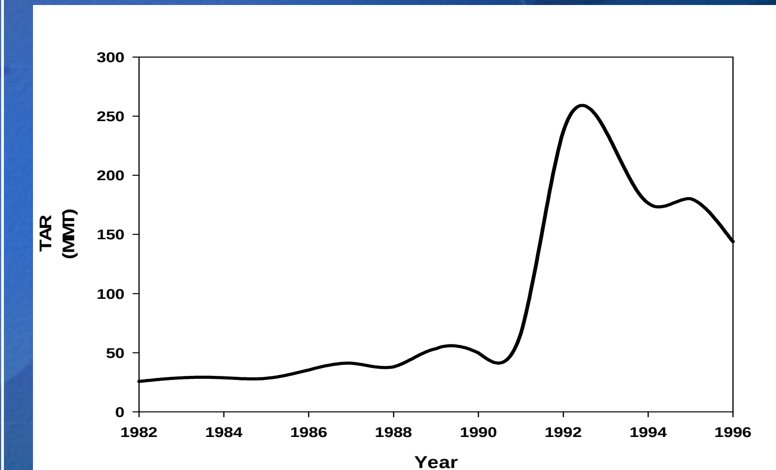
Import and export

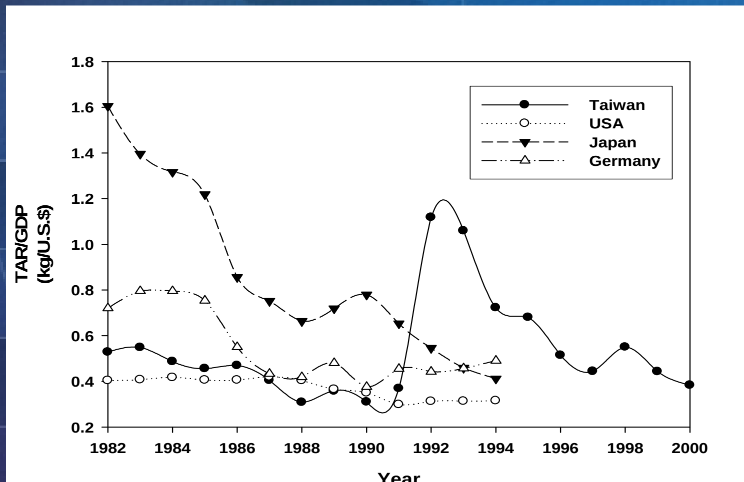
Per capita demand

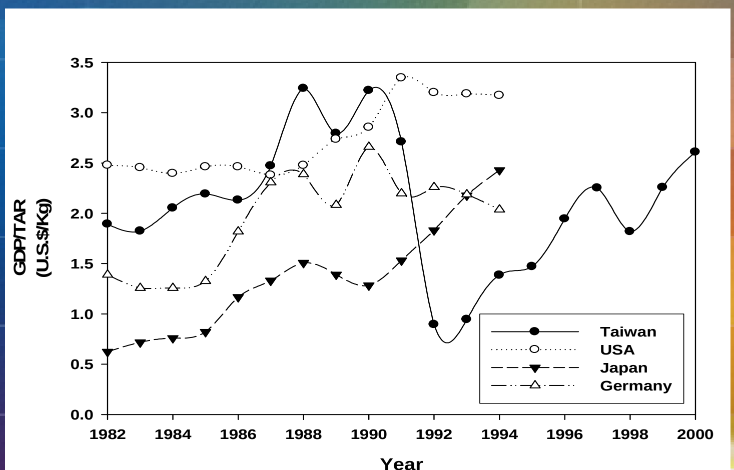
Per unit area demand

Total construction aggregates Requirements (include hidden flows)





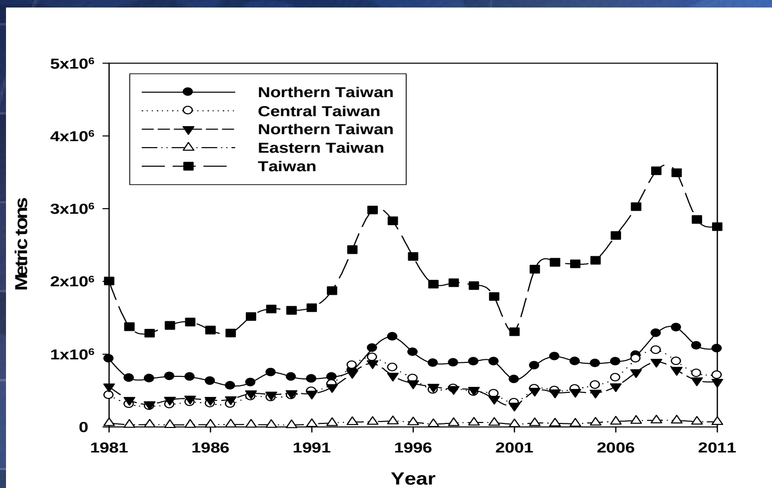




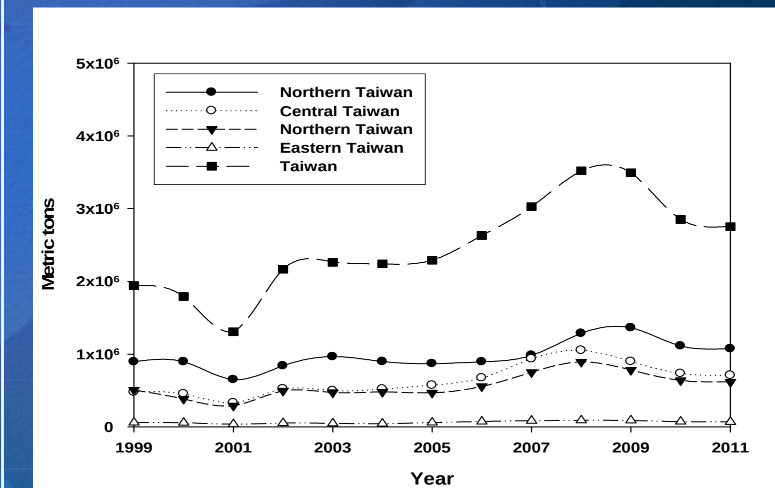
Intensity Use

Efficiency Use

Waste Concrete Output and prediction from Construction



Waste Concrete Output and prediction from Demolition



The aggregate resources deposits and recoverable reserves

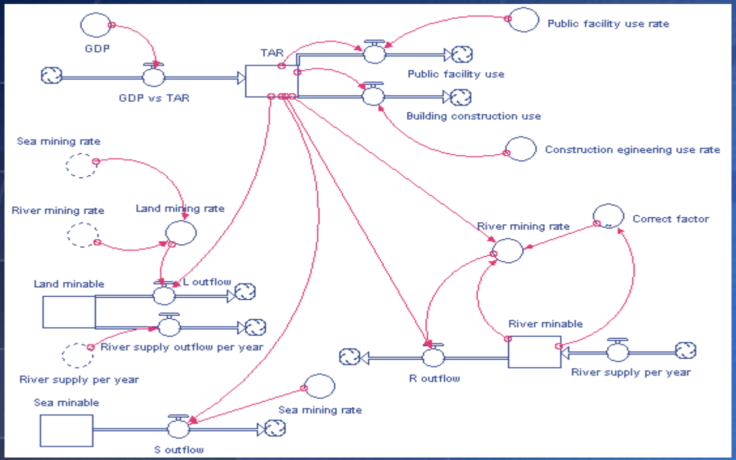
Table1 The aggregate resources deposits and recoverable reserves in Taiwan, 1998

Unit: Million Metric Tons (MMT)

Sources	Deposits	Recoverable Reserves
River Mining	4,292.65	590
Land Mining	137,770	137,770
Sea Area Mining	48,400-243,000	1,123

Source: ABRI, Ministry of Interior, 1998 a& b.

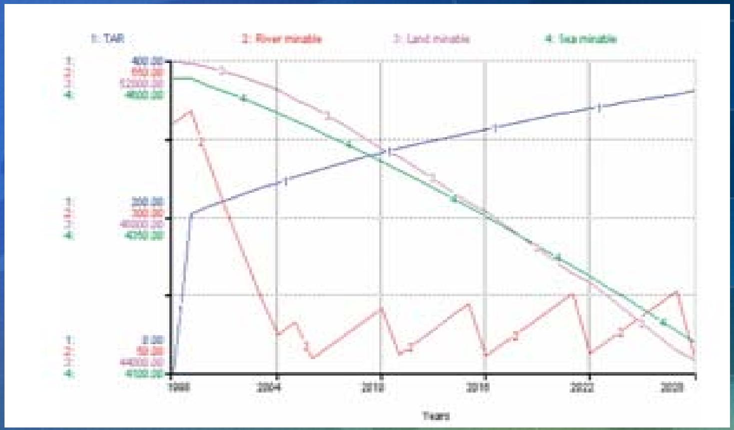
The model of supply and demand



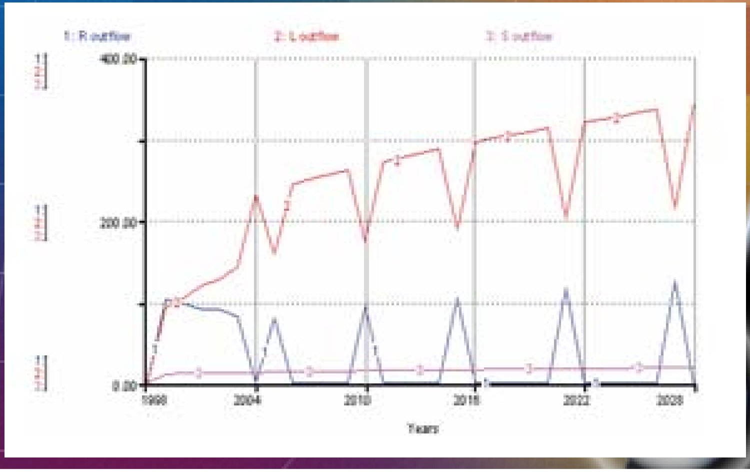
The parameters settings

Parameters	Names in model	Initial values or formulas
		Unit in MMT
Gross domestic production	GDP	443860(Year + 17)+435635 (million NT$)
Total construction aggregates requirements	TAR	0
The relation between GDP and total construction aggregates requirements	GDP vs TAR	TAR=164.46xlogN(GDP)-2410.6
Uses in construction for public facilities	Public facility use	TARxPublic engineering use rate
Uses in construction for building	Building construction use	TARxConstruction engineering use rate
Use rate in construction for public facilities	Public facility use rate	40%
Use rate in construction for building	Building construction use rate	60%
Minable aggregates in river	River minable	449
Annual supply aggregates in river	River supply per year	20.1
Minable aggregates in land	Land minable	51964
Minable aggregates in sea area	Sea minable	4571
Aggregates production from river	R outflow	TARxRiver mining rate
Aggregates production from land	L outflow	TARxLand mining rate
Aggregates production from land negative annual supply aggregates in river	River supply outflow per year	River supply per year
Aggregates production from sea area	S outflow	TARxSea mining rate
Mining rate in river	River mining rate	IF(River minable<TAR/2) then 0 else Correct factor
Correct factor of mining rate in river	Correct factor	30%-50% vs River minable continues function
Mining rate in land	Land mining rate	1- River mining rate- Sea mining rate
Mining rate in sea area	Sea mining rate	5%

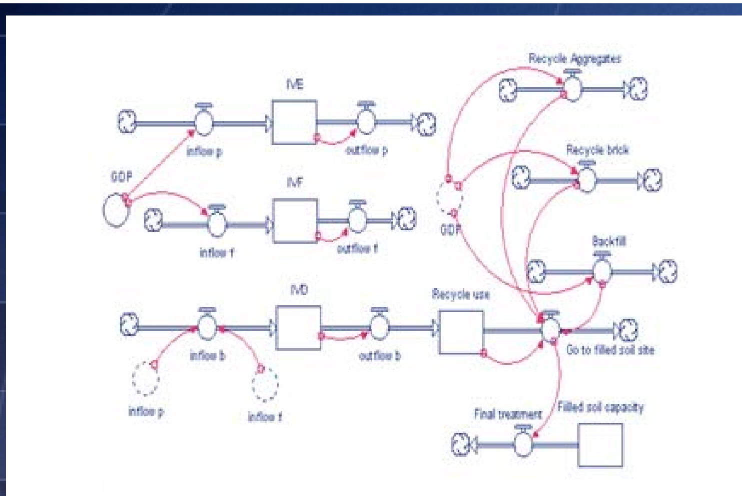
The forecast minable output (Unit: MMT)



The forecast mining output by sources (Unit: MMT)



The model of recycle and filled soil site capacity



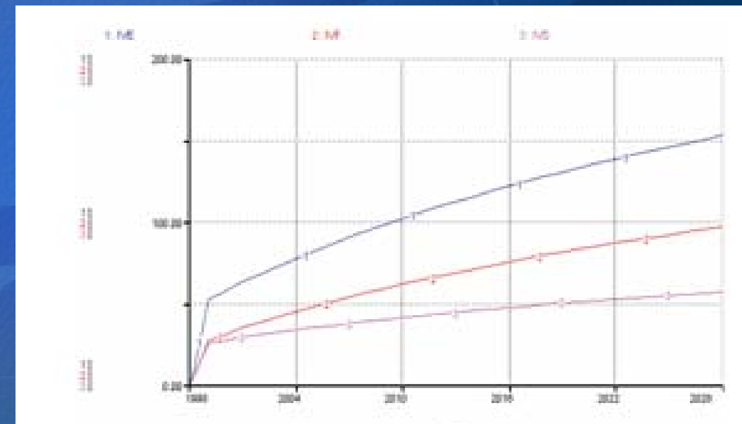
The parameters settings

Table 3 The parameters settings in RFM

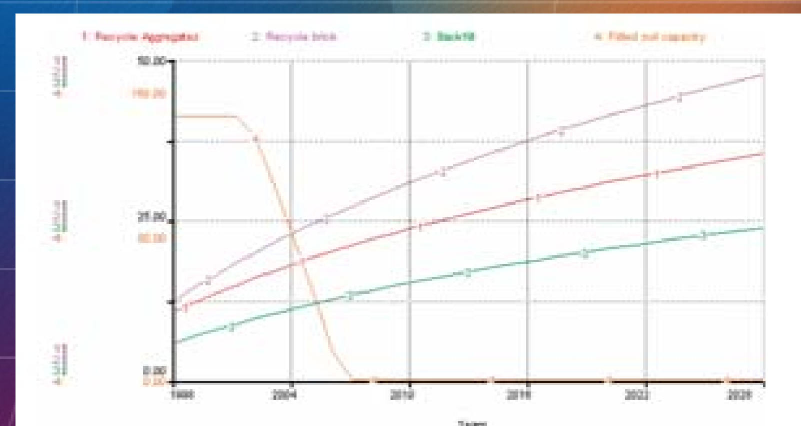
Unit in MMT

Parameters	Names in model	Initial values or formulas
Gross domestic production	GDP	443860(Time+17)+435635 (million NT$)
Initial value of remaining volume of earthwork	IVE	0
Initial value of volume of filled soil	IVF	0
Initial value of difference between volume remaining earthwork and filled soil	IVD	0
The relationship between remaining volume of earthwork and GDP	inflow p	105.43×LogN(GDP)-1624.1
The relationship between volume of filled soil and GDP	inflow f	72.663×LogN(GDP)-1128.2
The difference of inflow p and inflow f	inflow b	inflow p-inflow f
The volume of recyclable construction surplus soil balance	Recycle use	0
The relationship between recycle aggregates and GDP	Recycle Aggregates	25.01×LogN(GDP)-386.6
The relationship between recycle bricks and GDP	Recycle brick	35.78×LogN(GDP)-555.98
The relationship between backfill material and GDP	Backfill	18.27×LogN(GDP)-284.51
The volume of recyclable differences sending to filled site	Go to filled soil site	Recycle use-Recycle Aggregates-Recycle brick-Backfill
The capacity of the filled soil site	Filled soil capacity	132.22
The capacity of final treatment on filled soil site	Final treatment	Go to filled soil site

The forecast output for reuses (Unit: MMT)



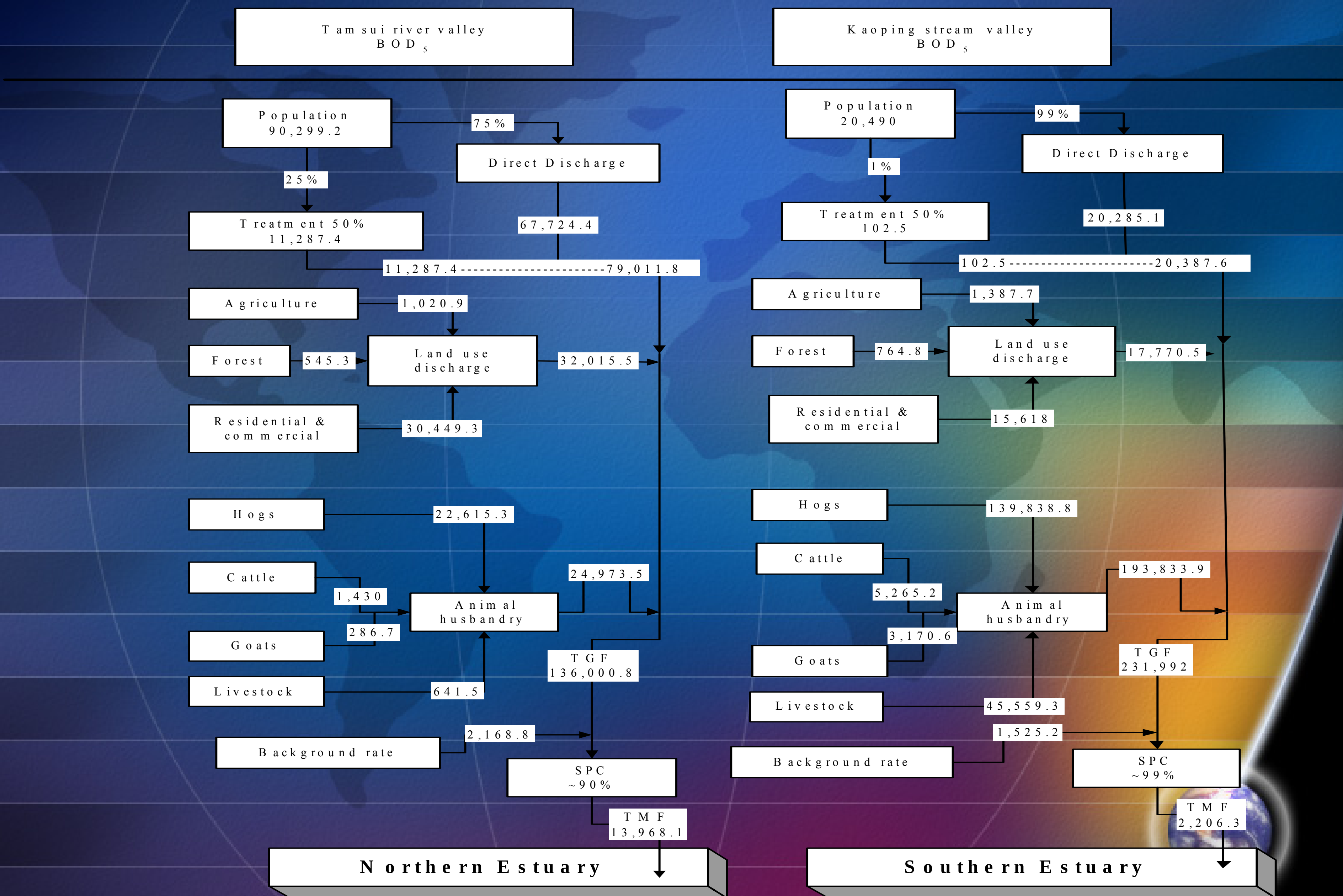
The forecast recycle and filled soil sites capacities (Unit: MMT)



Results (Valley Pollutants)

- We first predict, and then measure, the flows in Metric Tons (MT) of BOD_5 and SS resulting from the human and industrial activity in the Tamsui river and Kaoping stream valley from Year 1992 to 2000.
- Background rates are obtained using data collected upstream where human influences are minimal.

Total Predicted Flows of BOD_5, 2000



The Background rate and Total Predicted Flows(TPF) for BOD_5 in the Tamsui River and Kaoping Stream valleys: 1992- 2000 (All values in MT)

	Tamsui River Valley		Kaoping Stream Valley	
Year	Background rate	TPF	Background rate	TPF
1992	1,134.3	150,120.6	1,604.5	272,212.1
1993	588.7	147,442.2	1,049.9	271,425.7
1994	938.8	144,252.6	3,143.2	280,563.8
1995	619.6	144,624.0	1,277.5	287,460.2
1996	756.8	144,704.9	1,856.7	302,423.6
1997	649.2	146,238.5	2,041.1	307,092.7
1998	1,385.2	143,201.9	1,773	232,146.9
1999	692.7	140,570.2	1,430.1	216,722.2
2000	2,168.8	136,000.8	1,525.2	231,991.9

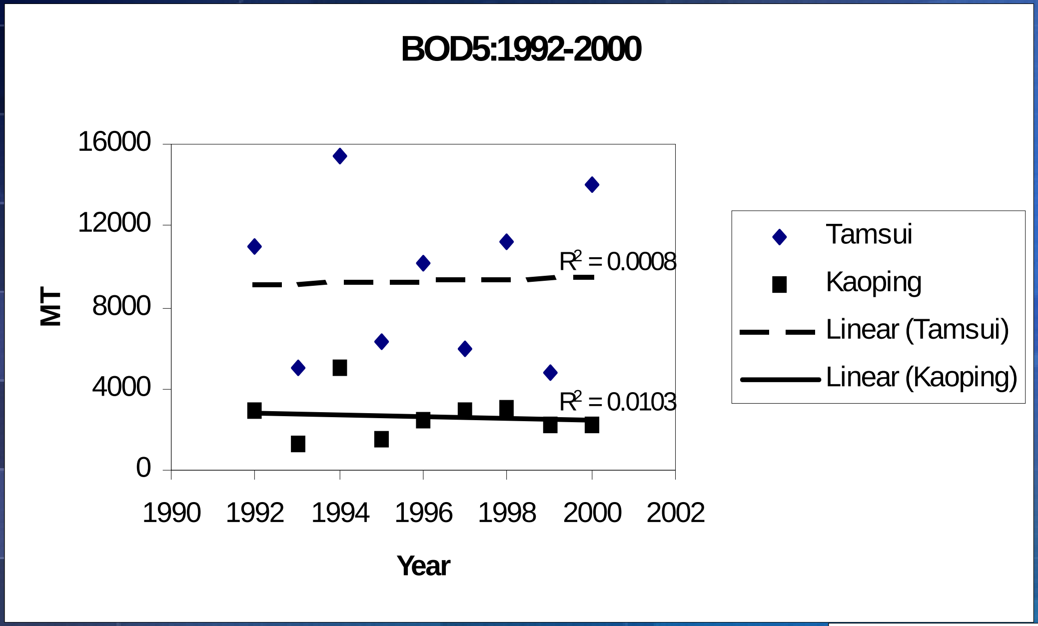
Derived from Taiwan EPA & Water Resources Agency

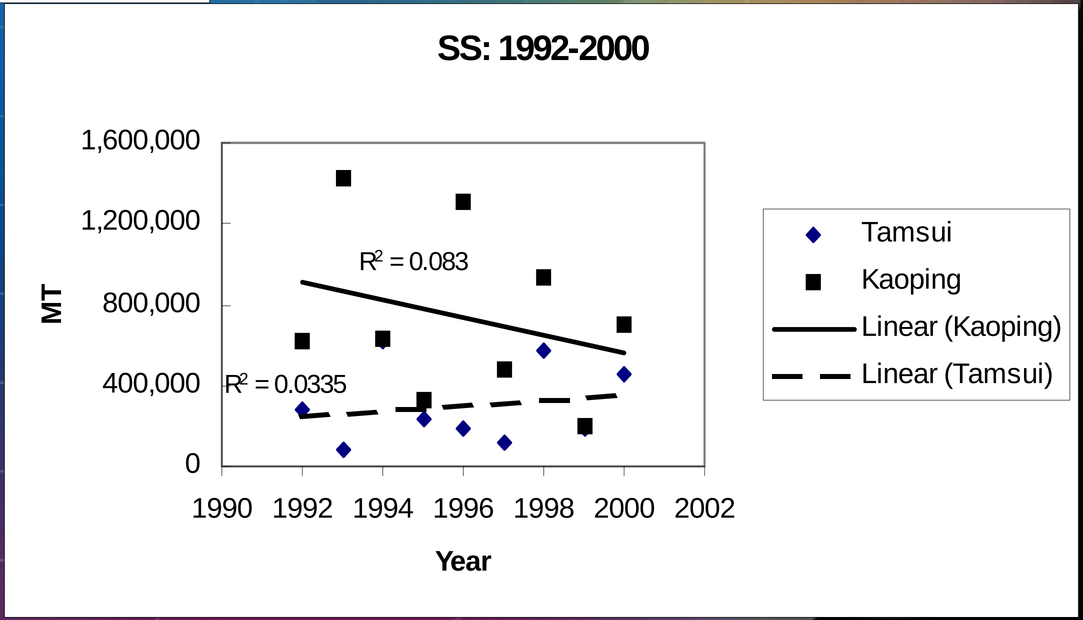
Measured flows, Background rates, and Human Contributions from Human Activity for SS in the Tamsui River and Kaoping stream valley: 1992- 2000 (All values in MT)

	Tamsui River Valley			Kaoping Stream Valley		
Year	Measured Flow	Background rate	Contribution from Human Activity	Measured Flow	Background rate	Contribution from Human Activity
1992	282,820.2	17,684.2	265,136	622,859	251,319.6	371,539.4
1993	86,970.9	10,914	76,056.9	1,430,399.4	478,815.4	951,584
1994	613,295	22,320.5	590,974.5	627,931	275,838.4	352,092.6
1995	236,326.7	11,065	225,261.7	321,363.2	197,106.2	124,257
1996	181,812.8	11,089.5	170,723.3	1,305,420	466,030.4	839,389.6
1997	111,844.3	8,545.8	103,298.5	477,818.7	377,062.4	100,756.3
1998	570,266.9	44,461.3	525,805.6	931,768.1	501,066.5	430,701.6
1999	186,183.6	9,499.6	176,684	193,494	156,898.3	36,595.7
2000	457,813.7	16,660.3	441,153.4	698,527.9	517,325.5	181,202.4

Derived from Taiwan EPA & Water Resources Agency

Total Measured flows of BOD_5 and SS





- Using the TPF and TMF to calculate each river system's Self Purification Capability SPC as :

$$SPC=1-[TMF/(TPF + Background)]$$

- For BOD_5 the average SPC in the northern watershed is 0.94±0.03. The southern watershed is 0.99±0.005.

Conclusions and Recommendations

- MFA is a useful analytical tool that provides information on the flows of materials through economies to the environment.

- The results of MFA provide an understanding and overview of both the direction of materials’ flows and the quantity of these flows.

- All of these results are aimed to assist government over planning and management of material uses, as well as to reduce environmental impacts of economic and human activities.
- To integrate governments’ resources to establish a research center, like the Wuppertal Institute (Wuppertal and Berlin Germany), World Resources Institute (Washington D.C. USA).

The END

Thanks for your attention.

Further reading：

1.Teng Yuan Hsiao, Yue Hwa Yu, Iddo K. Wernick ”A Note on material flows of construction aggregates in Taiwan”, Resources Policy (SSCI), Vol. 27/2, p.135-137, 2001.

2.T. Y. Hsiao, Y. T. Huang, Y. H. Yu, I. K. Wernick ”Modeling Materials Flows of Waste Concrete from Construction and Demolition Wastes in Taiwan”, Resources Policy (SSCI), Vol. 28/1-2, p. 39-47, 2002.

3.T. Y. Hsiao,N. W. Kuo, Iddo K. Wernick, L. T. Lu, Y. H. Yu ” Materials Flow Analysis of Pollutants in Taiwan”,International Journal of Environment and Pollution (SCI), Vol. 23, No.3, p. 259-272, 2005.