# 台灣地區砂石與流域污染物物質流分析

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# 大綱

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# 前言

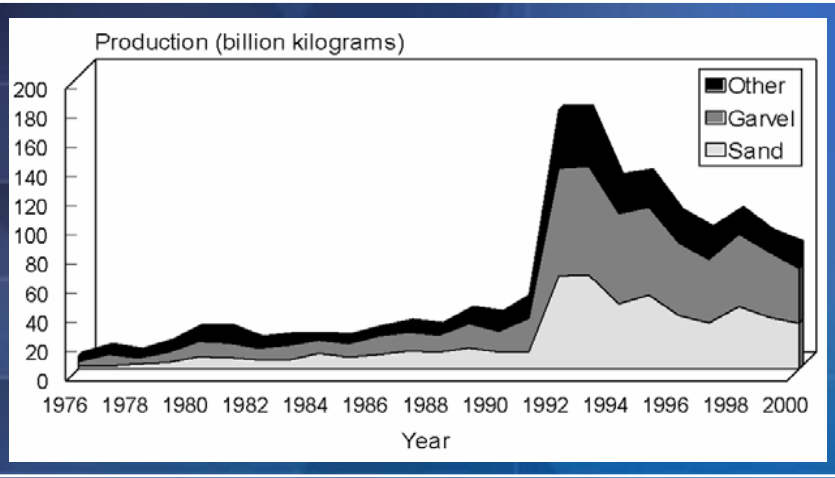
- 近年來台灣地區因經濟與產業發展，已加速砂石之需求與使用，人口聚集都會地區亦造成河川污染物之快速累積。
- 本研究乃應用物質流分析之理論基礎，從事下列相關研究：
  - 砂石。
  - 南、北台灣流域污染物，包括生化需氧量($BOD_5$), 懸浮固體物 (SS) (以具高人口密度特性之淡水河流域與以農畜與重工業發展為主之高屏溪流域為例)。

# 研究目的

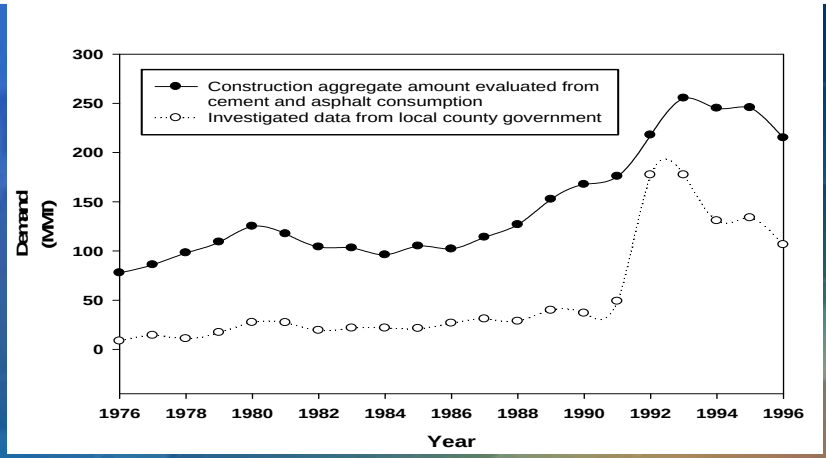
- 發展台灣地區砂石與流域污染物物質流分析與評估系統。
- 衍生開發非線性與動態模擬模式，以支援政府部門決策與國家擬定去物質化政策之科學化參考依據。

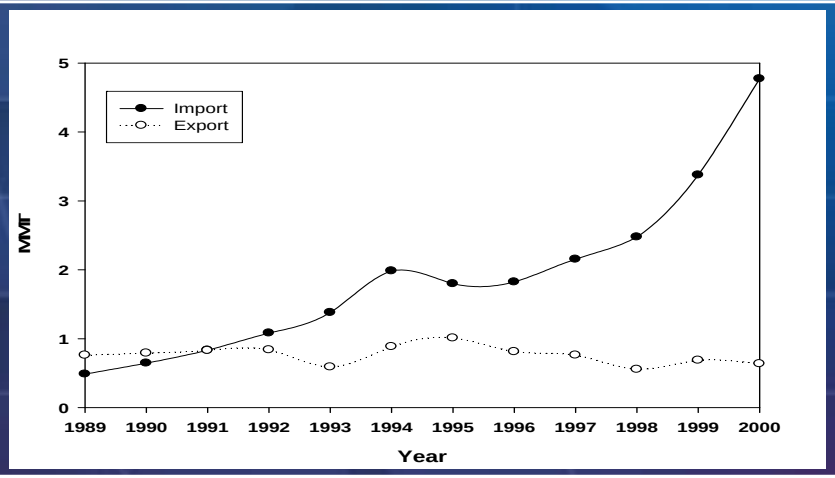
# 研究成果（砂石）

國內自產量

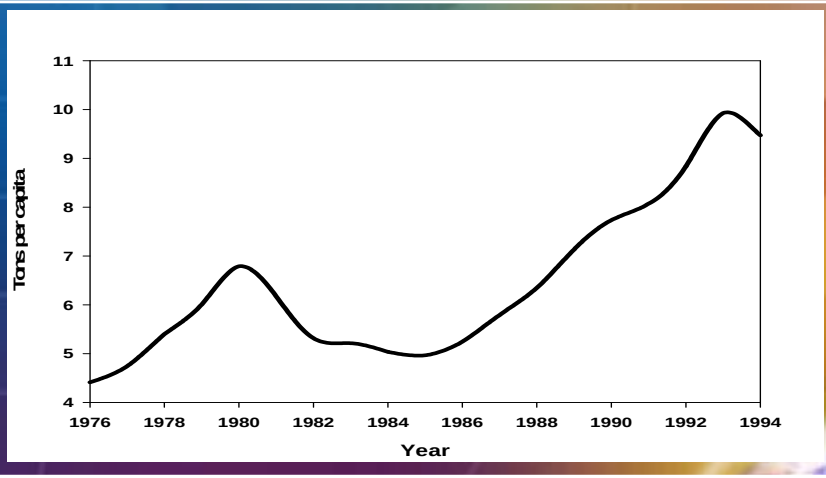



需求量



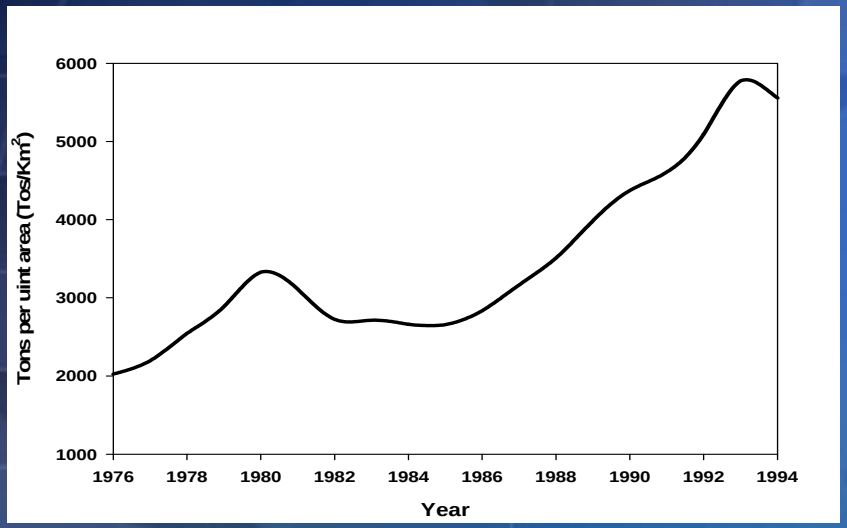




進出口量

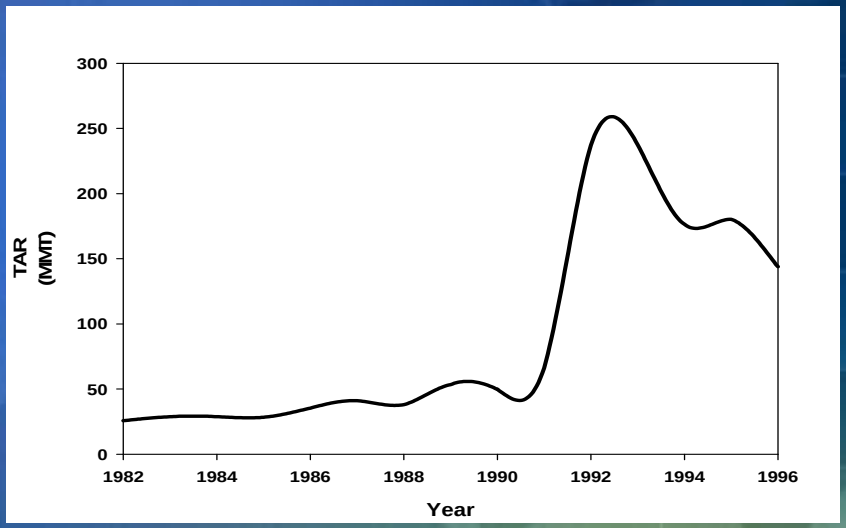



每人需求量

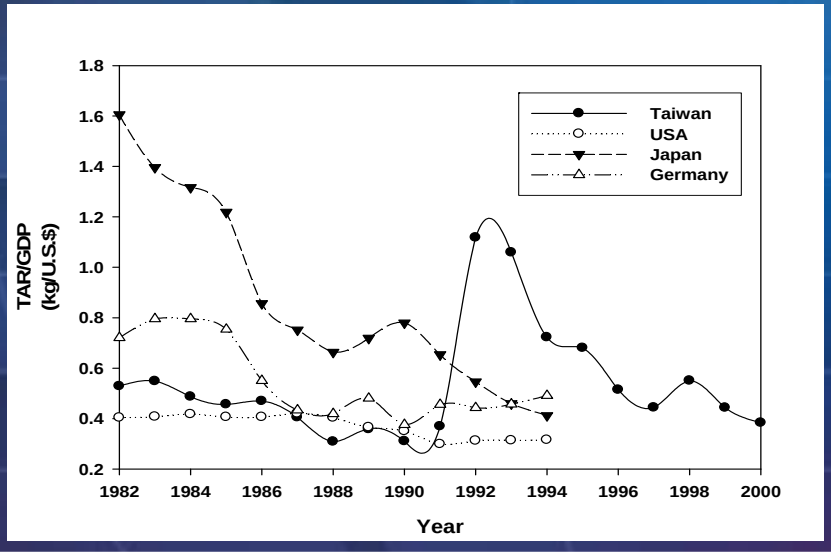
每單位面積需求量



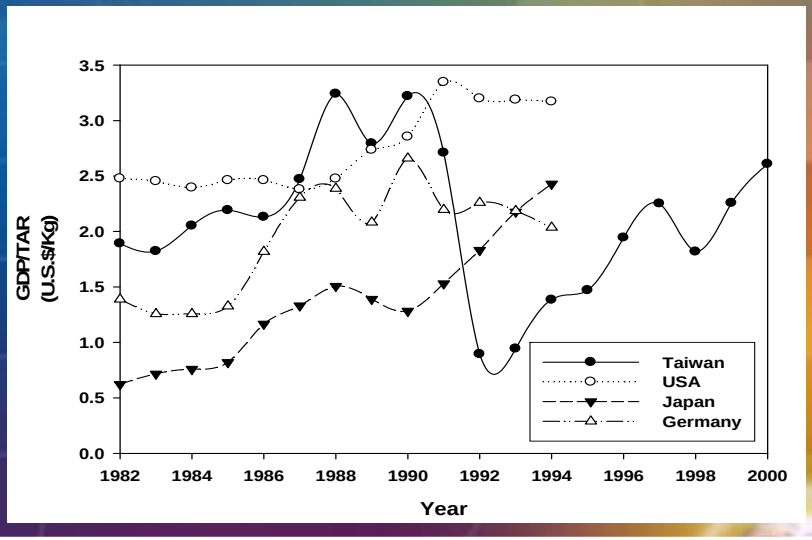

總砂石需求量（含隱藏流）



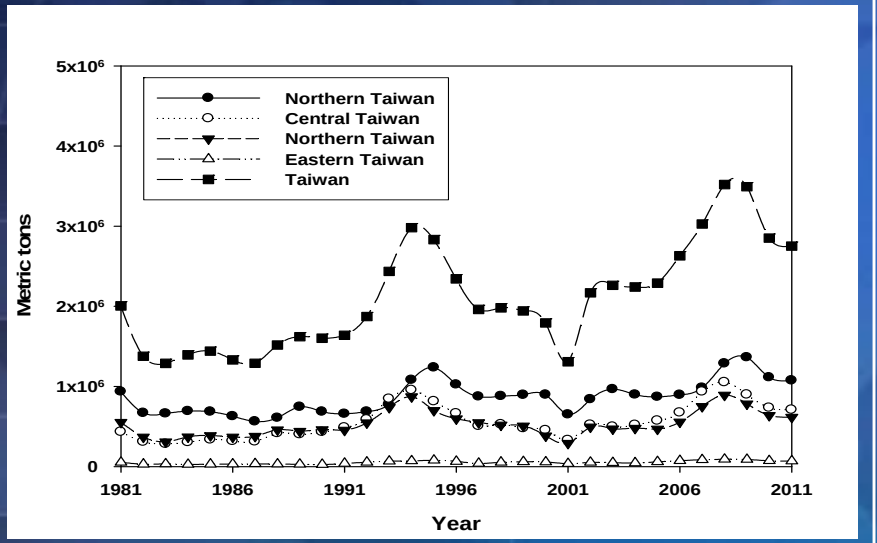

使用強度



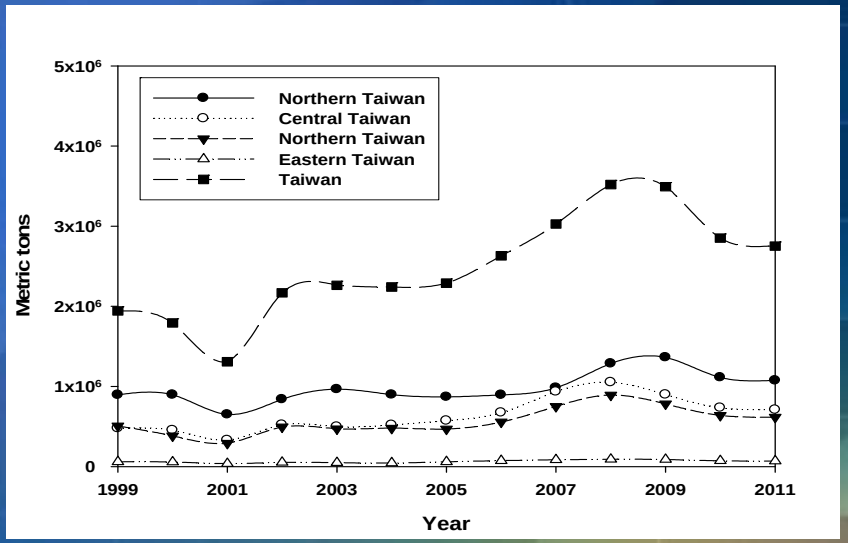

使用效率



## 建築工程廢棄混凝土量與趨勢預測




## 拆除工程廢棄混凝土量與趨勢預測




## 1998年砂石資源蘊藏與可採量

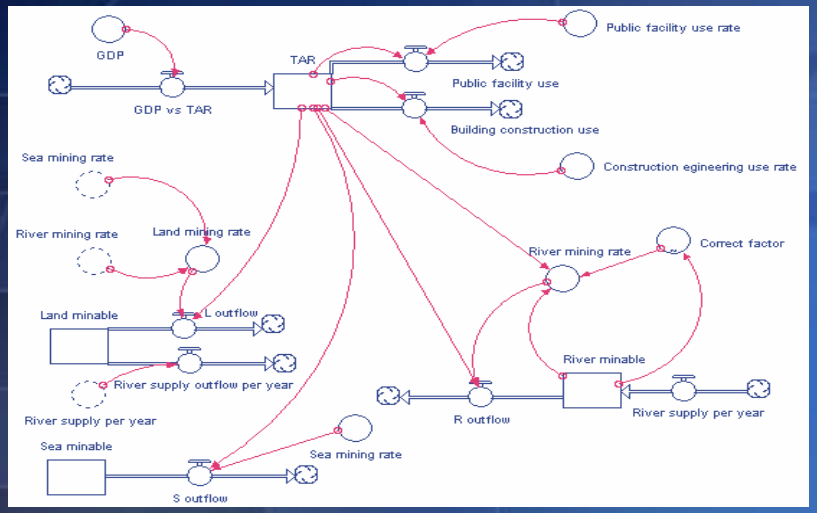
Table1 The aggregate resources deposits and recoverable reserves in Taiwan, 1998

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.

# 供需模型

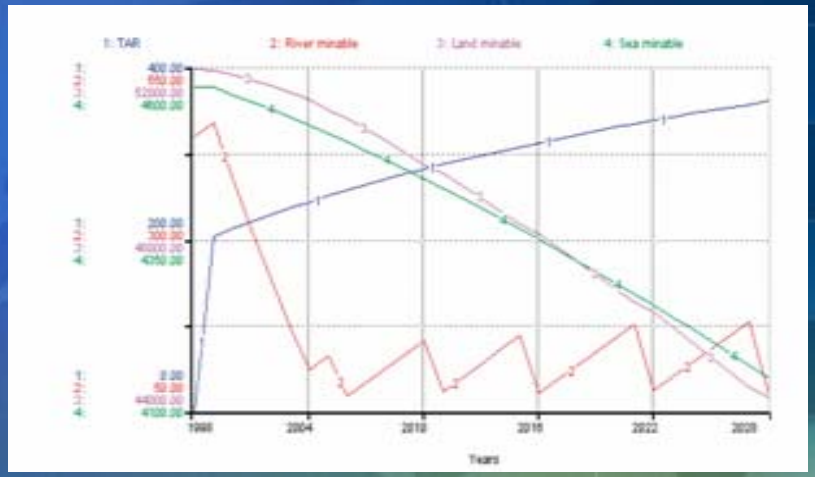



## 參數設定

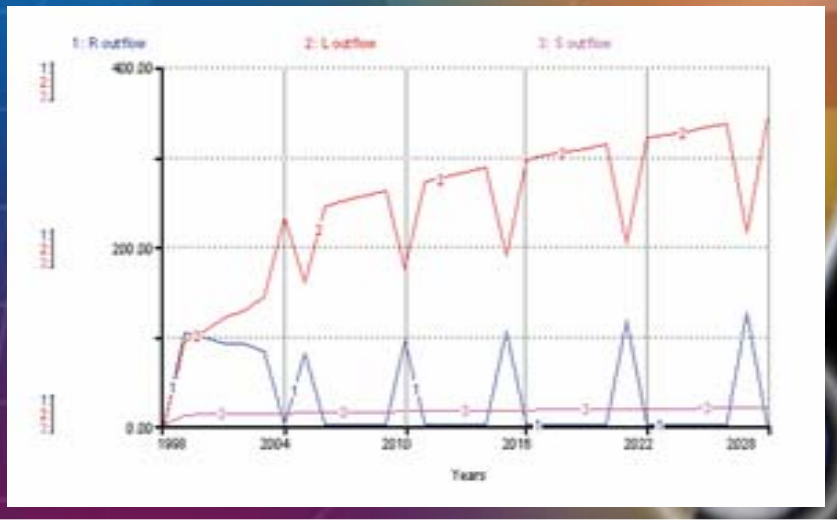
Unit in MMT

| Parameters | Names in model | Initial values or formulas |
|---|---|---|
| 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% |

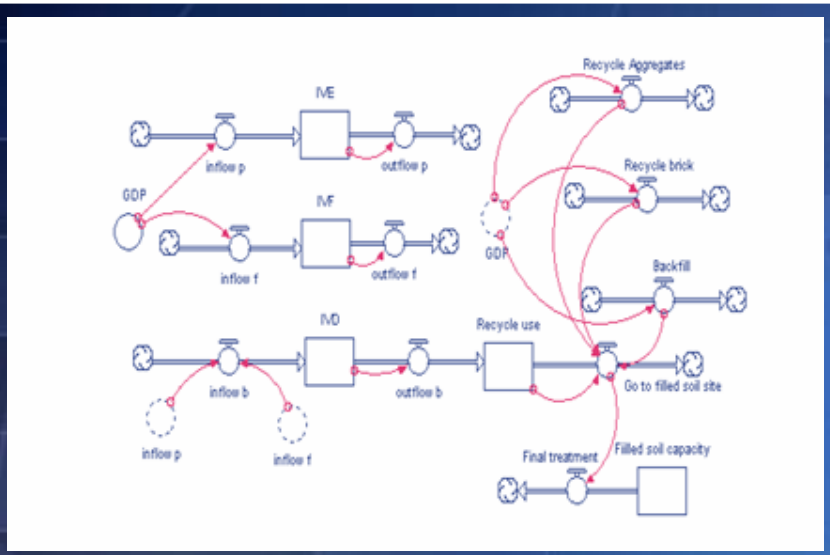
## 可採量預測
## （單位: 百萬公噸）




## 來源量預測
## （單位： 百萬公噸）



# 回收與棄土場涵容量模型



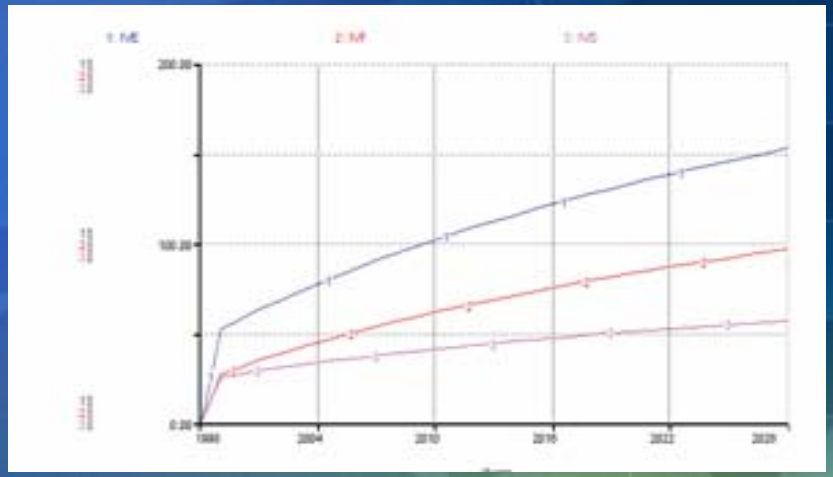

## 參數設定

Table 3 The parameters settings in RFM

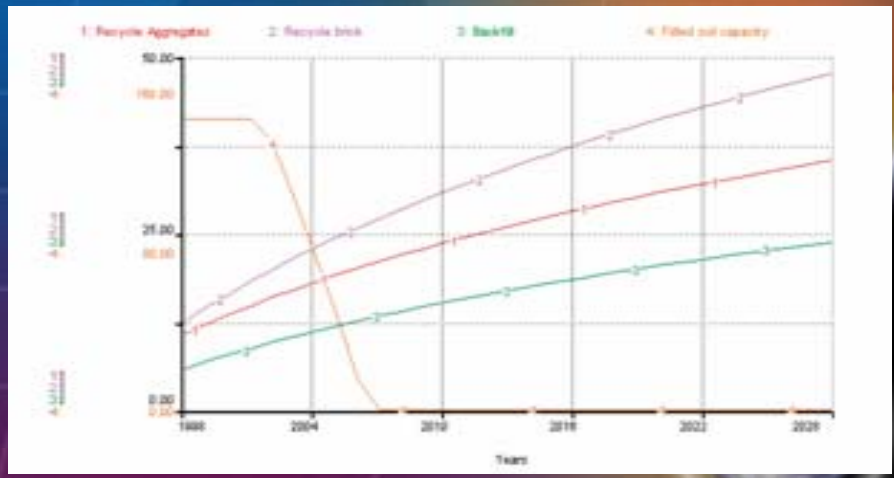
Unit in MMT

| 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 |

## 回收再利用量預測
## (單位: 百萬公噸)



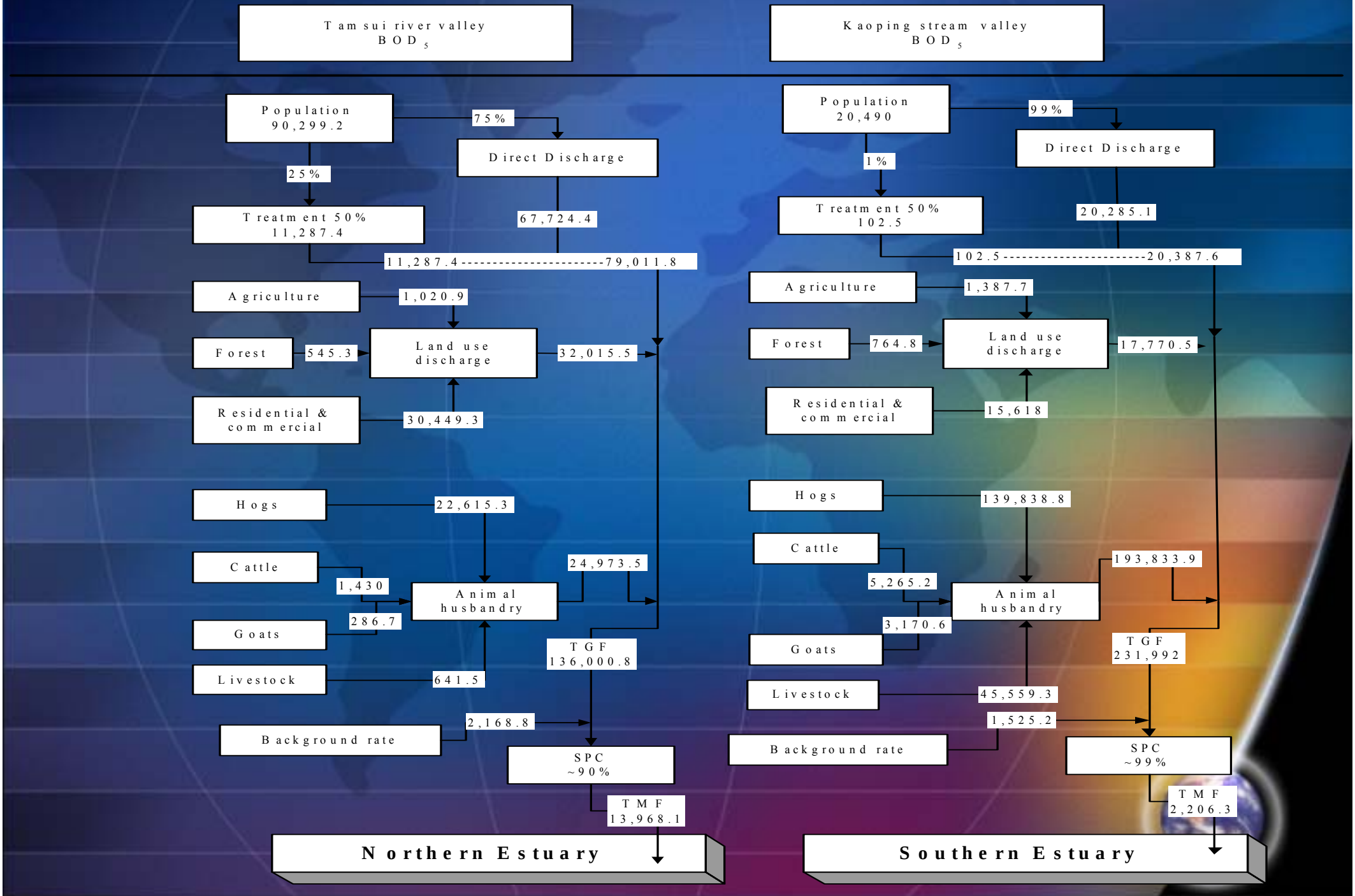
## 回收量與棄土場涵容量預測
## (單位: 百萬公噸)



# 研究成果（流域污染物）

- 藉由預測量與監測量資料分析與檢視1992-2000年淡水河與高屏溪流域人類經濟活動之有機污染物($BOD_5$)與懸浮固體物。
- 背景值以人類經濟活動影響最低之流域上游監測值為依據。

# 生化需氧量($BOD_5$)總預測量, 2000



# 1992-2000年淡水河與高屏溪流域生化需氧量($BOD_5$)背景值與總預測量

（單位：萬公噸）

| | 淡水河流域 | | 高屏溪流域 | |
|---|---|---|---|---|
| 年度 | 背景值 | 總預測量 | 背景值 | 總預測量 |
| 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 |

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# 1992-2000年淡水河與高屏溪流域懸浮固體物(SS)監測量，背景值與人類活動貢獻值

（單位：萬公噸）

| | 淡水河流域 | | | 高屏溪流域 | | |
|---|---|---|---|---|---|---|
| 年度 | 監測量 | 背景值 | 人類活動貢獻值 | 監測量 | 背景值 | 人類活動貢獻值 |
| 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 |

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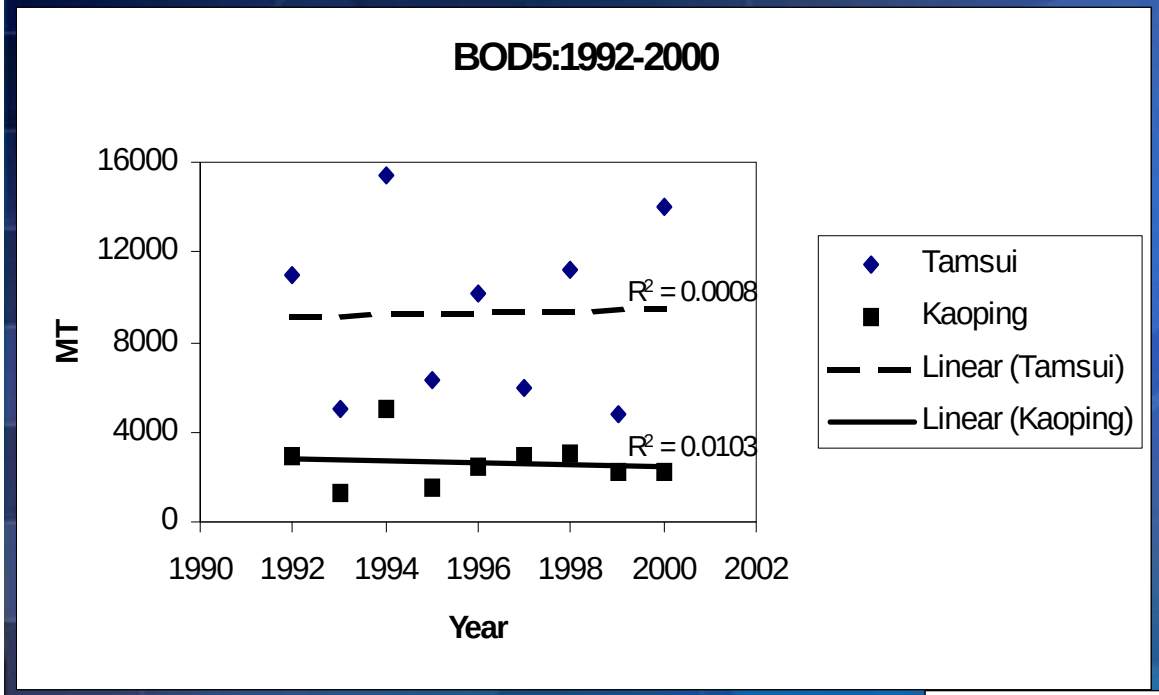
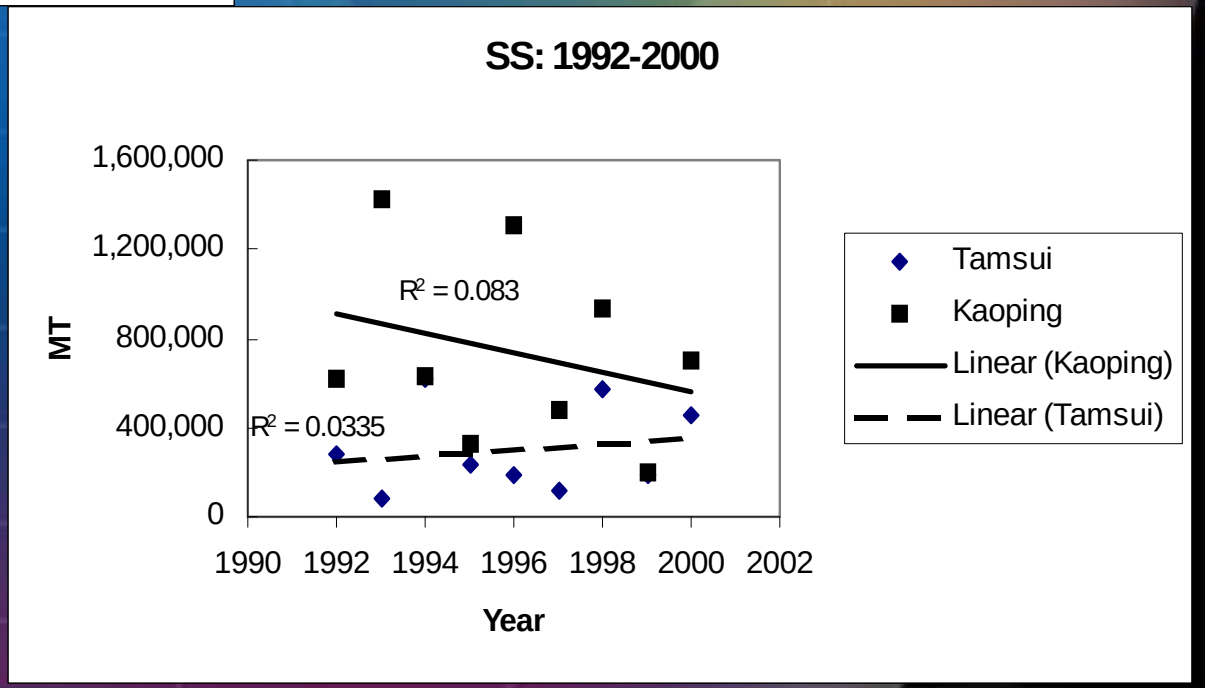
# $BOD_5$ 與 SS總監測量



- 利用總預測量與總監測量計算河川自淨能力(自淨能力Self Purification Capability）:

  自淨率=1-[總監測量/(總預測量＋背景值)]

- 1992-2000年有機污染物淡水河流域平均自淨率 0.94±0.03. 高屏溪流域平均自淨率 0.99±0.005.

# 結論與建議

- 物質流分析可提供物質自環境 ——→人類經濟活動 ——→環境之全盤資訊。
- 物質流分析結果可提供了解與檢視物質流量與流向之交互關係。

- 本研究成果可協助政府規劃與管理物質之超限使用，進而降低因經濟與人類活動所帶來之環境衝擊。

- 建議整合政府跨部會資源，成立一專責研究機構，如Wuppertal Institute (Wuppertal and Berlin 德國), World Resources Institute (Washington D.C. 美國).

# 簡報結束
# 敬請指教

進階資料：

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.