

**Some Recent Studies on Material Flows
Analysis in Taiwan**

**2007 Seminar on Material Flows
January 18, 2007**

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I. Motivation and Initiation of Material Flows Analysis (MFA) in Taiwan

- **1. Some pioneer research groups in USA, EN, and Asia**
- WRI (World Resource Institute) (Washington DC, USA), WI (Wuppertal Institute) (Wuppertal, Federal Republic of Germany), NMOH (Netherlands Ministry of Housing, Spatial Planning and Environment) (The Hague, Netherlands), NIES (National Institute for Environmental Studies) (Tsukuba, Japan), Paul H. Brunner (Professor and Head, Institute for Water Quality, Resource and Waste Management, Vienna University of Technology, Austria), Tetsuya Nagasaka (Professor, Department of Materials Science & Engineering, Faculty of Engineering, Tohoku University, Japan), J.H. Ausubel (Professor, Columbia University), and Dr. I.K. Wernick (with Columbia University previously and WRI presently).

2. Some pioneer studies

- Wernick, I.K. and J.H. Ausubel, “National Material Flows and the Environment,” *Annual Review Energy and Environment*, 20, 463-492 (1995).
- WRI (World Resource Institute) (Washington DC, USA), WI (Wuppertal Institute) (Wuppertal, Federal Republic of Germany), NMOH (Netherlands Ministry of Housing, Spatial Planning and Environment) (The Hague, Netherlands), and NIES (National Institute for Environmental Studies) (Tsukuba, Japan), *Resource Flows: the Material Basis of Industrial Economies*, WRI, Washington, D.C., USA (1997).
- Ausubel, J.H., “Resource and Environment in the 21st Century: Seeing Past the Phantoms,” *World Energy Council J.*, July, 8-16 (1998).

3. Initiation

- **Steering initiators:** Y.H. Yue (National Taiwan University, NTU) and I.K. Wernick (Columbia and WRI).
- **Working groups:** C.Y. Chang, (NTU), Y.M. Lee (National Taipei University, NTPU), S.L. Liao (National Central University, NCU), H.W. Ma (NTU), C.F. Ho Chang (Chung-Yuan Christian University, CYCU), T.Y. Hsiao (NTU and Jin-Wen Technical College), N.W. Kou (Taipei Nursery Science and Technology College), and others.

II. Continuing Studies

- **1. More researchers involved**
- Researchers from sectors of governmental administration, consulting engineering, manufacturing, and academic institutes.

- **2. More factors examined**
- Consideration including factors other than materials, such as energy and risk analyses.

- **3. More deep, wide, and practical**
- Extending the studies from National wide to local levels, industries to individual firms, and strategic to common materials.

III. Some example studies

- 1. Lin, S.S., “Preliminary Study on Material Flow System and Its Establishment in Taiwan,” Master Thesis, Department of International Trade, Chung Yuan Christian University, Taiwan (2001).
- 2. Chang, C-F H. and S.S. Lin, “Material Requirements of Metals in Taiwan,” J. Chinese Inst. Environ. Eng. (Taiwan), 12(2), 93-102 (2002).
- 3. Chang, C-F H. and S.S. Lin, “Material Requirements of Agricultural, Forest and Animal Biomass Industries in Taiwan,” J. Chinese Inst. Environ. Eng. (Taiwan), 12(4), 315-324 (2002).

- 4. Chang, C-F H., Y.C. Liu, C.Y. Chang, A.C. Chiang and S.S. Lin, “Scenario Analysis of Material Flow of Steel and Iron for the Steel Industry in Taiwan and International Comparison of Per Capita of Use and Intensity of Use,” J. Chinese Inst. Environ. Eng. (Taiwan), 12(4), 325-335 (2002).
- 5. Chang, C-F H. and S.S. Lin, “Material Flow Analysis of Industrial Non-metal Minerals in Taiwan,” J. Chinese Inst. Environ. Eng. (Taiwan), 13(3), 183-190 (2003).
- 6. Chang, C-F H., I.H. Lee, J.L. Shie and C.Y. Chang, “Estimation and Trend Analysis of Biomass Production in River Basin in Taiwan: 1. Case in Tamsui River Basin,” J. Chinese Inst. Environ. Eng. (Taiwan), 14(1), 1-8 (2004).

- 7. Chang, C-F H., H.L. Lu, C.Y. Chang, H.W. Ma and Y.H. Chen, “Estimation and Trend Analysis of Biomass Production in River Basin in Taiwan: 2. Case in Gaobing River Basin,” J. Chinese Inst. Environ. Eng. (Taiwan), 14(1), 9-16 (2004).
- 8. Chang, C.F.H., P.L. Huang, Y.H. Chen and C.Y. Chang, “A Comparative Study on Key Factors of Sustainable Development Related to Biomass Production in Three Major River Basins in Taiwan,” J. Environ. Eng. and Manag. (formerly, J. Chinese Inst. Environ. Eng.), 16(5), 333-341 (2006).
- 9. Hsiao, T.Y., Y.H. Yu and I.K. Wernick, “A Note on Material Flows of Construction Aggregates in Taiwan,” Resour. Policy, 27(2), 135-137 (2001).

- 10. Hsiao, T.Y., Y.T. Huang, Y.H. Yu and I.K. Wernick, “Modeling Material Flow of Waste Concrete from Construction and Demolition Waste in Taiwan,” *Resour. Policy*, 28(1-2), 39-47 (2002).
- 11. Hsiao, T.Y., Y.H. Yu and I.K. Wernick, “Analyzing Material Flows for Construction Aggregates in Taiwan,” *J. Chinese Inst. Environ. Eng. (Taiwan)*, 12(2),103-112 (2002).
- 12. Hsiao, T.Y., “A Study on Industrial Ecology – Analyzing and Modeling Materials Flows for Construction Aggregates in Taiwan,” Ph.D. Dissertation, Graduate Institute of Environmental Engineering, National Taiwan University, Taipei, Taiwan (2003).

IV. Case study of biomass production in three major river basins in Taiwan

- **A COMPARATIVE STUDY ON KEY FACTORS OF SUSTAINABLE DEVELOPMENT RELATED TO BIOMASS PRODUCTION IN THREE MAJOR RIVER BASINS IN TAIWAN**
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- **Key Words:** Biomass, biomass production, agricultural production, Choushui River basin, Tamsui River basin, Gaobing River basin, Taiwan

ABSTRACT

- This study analyzed the variations of the biomass (including crop, forestry, fishery and livestock) production in the Choushui River Basin in the middle Taiwan to establish the useful information and indicators. The material production of biomass materials (MPB) during 1987 to 2002 were computed from the available data and assessed. The results revealed that the contribution of rice planting in the Choushui River Basin had decreased recently. Accordingly, the contribution of rice production (M_R) in the Choushui River Basin for the whole rice product (M_{RTWN}) in Taiwan also reduced as well. The values of M_R/M_{RTWN} with the slight variation had the

- average value of 8.3% with the maximum and minimum values of 9.2% in 1988 and 6.9% in 1999, respectively. Furthermore, MPB in the Choushui River Basin generally increased before 1993 and after 1997, and had the lower value in 1994-1996 (968,670–1,020,550 tons). In overall, the values of MPB were 961,760 and 1,265,420 tons in 1987 and 2002 with average value of 1,143,850 tons. In addition, the variations of the ratio of farm to total populations (P_{Fa}/P_T) and cultivated land area (A_C) were addressed. The values of P_{Fa}/P_T and A_C were

- 54-64% and 54,070-58,770 ha with average values of 60% and 57,660 ha, respectively. The biomass production per employee of biomass industry (MPB/E_B) in the Choushui River basin exhibited gradually increasing trend with minimum and maximum values of 9.3 tons/person in 1990 and 19.42 tons/person in 2002. The average value was 13.2 tons/person. It indicated an improvement of productivity of biomass by the employee of biomass industry. Further, the biomass production and key factors of sustainable development noted above in the Choushui River Basin were compared with those of the Tamsui and Gaobing river basins.

V. Goals to Achieve

- 1. Efficient utilization of materials and energy.
- 2. High productivity.
- 3. Minimization of wastes, pollutants, and risk.
- 4. De-materialization.
- 5. Sustainable development.