別紙4 （課程博士）

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Abstract
論文内容の要旨　（博士）

Title of Thesis 博士学位論文名	ASSESSMENT OF PHYSICAL ECONOMY THROUGH MATERIAL FLOW ANALYSIS FOR ESTABLISHING SUSTAINABLE SOCIETY IN UZBEKISTAN （ウズベキスタンにおける持続社会形成のための物質フロー解析による物質経済の分析）

(Approx. 800 words)

Over the past decades, increased demand on natural resources is considered a serious threat to well-functioning economies and societies due to associated environmental problems such as desertification, ecosystem degradation and climate change. A main driver of human induced environmental changes has been the growing social or industrial metabolism, that is, the inputs of materials and energy into socio-economic systems and the corresponding outflows of wastes and emissions. Sustainability has been defined by the United Nations as a global process of development that minimizes the use of environmental resources and reduces the impact on environmental sinks using processes that simultaneously improve the economy and the quality of life. A better understanding of the patterns and trends of changes in nation's social metabolism helps to understand the dynamics of human-environment relations.

In this study, uniquely, indeed for the first time for the country, which is the primary focus of it, we assess the physical dimensions of Uzbekistan's economy for period of 1991-2012. Transition from state-planned to market economy since independence of Uzbekistan bring many reformations in socioeconomic system of country. The metabolic profile of country is altered due to the economic growth and population increased during transition period.

We depicted macroscopic picture of physical economy of Uzbekistan by using Material Flow Analysis (MFA) method which is an internationally recognized tool for such assessments. MFA is used to develop a better understanding of the flow of materials through an industry and connected ecosystems, to calculate indicators, and to develop strategies for improving material flow systems. MFA cover all material inputs apart from water and air of a national economy in tonnes per year. The material flows data set comprises of consistent data for domestic extraction (DE), imports and exports as well as for derived material flow indicators. The main material sub-categories we looked at in our accounts were fossil fuels, biomass and minerals. There have been a number of studies using methodological standardization of MFA, but to the best of our knowledge, it has never been used to assess the metabolism of Central Asian economies, especially, in this case, the Republic of Uzbekistan.

· Our analysis on evaluation of macroscopic economic activities in Uzbekistan depicted that the input indicators of direct material input (DMI) and total material requirements (TMR) showed a slight increase with an average growth rate (AGR) of 2.79% and 2.34% during period of study. The trends of GDP per DMI

shows the material efficiency of economy is continued to increase from 57 in 1992 to 88 USD per tonne in 2011, with an AGR of 2.63%. Since second decade of study relative decoupling has occurred. In international comparison analysis we found that input indicators, DMC and material efficiency (GDP/DMI) depicted lower than comparative countries. In three-phased period in two decades, we obtained the close relationship between economy-wide MFA based indicators and government macro policy implementation.

We assessed the main drivers of material use in socio-metabolic transition through disaggregated MFA in Uzbekistan by a range of categories and sub categories. In per capita terms, DE has increased from 9.8 to 10.9 tonnes in two decades. Biomass extraction increased with the highest AGR of 3.6%. In Physical trade balance (PTB) Uzbekistan transferred to be a net exporter of fossil fuels and net importer of biomass products in second decade of study. DMC has increased with an AGR of 1.8% mainly driven by biomass 3.6% and construction minerals 2.8% used in period of study. The environmental impact analysis through IPAT model depicted that the development of DMC in Uzbekistan mostly driven by economic growth and technological change during its transition period of study.

Through initial assessment of energy transition by developed set of MFA-based energy indicators for Uzbekistan we obtained energy imports dependency significantly reduced and domestic energy extraction (DEE) was dominant (96%) in total energy input in Uzbekistan since second decade. An average natural gas was dominant in domestic energy consumption (DEC) and energy exports with share of 81% and 72% respectively. Although energy intensity GDP per DEC is contracted from 1.7 to 0.5 kg per USD, Uzbekistan is still highly dependent on fossil fuels despite having high potential on renewable energy source in country. However, in environmental assessment we obtained that Total energy requirement (TER) has decreased with an AGR of -0.5% and the hidden energy flows presented a lower level of environmental impacts in Uzbekistan due to a reduction of energy imports and dominance of natural gas energy source, which has a lower ratio in calculation of hidden energy flows.

We summarized that the development of all categories of material flows was indispensable for the socio-economic development of Uzbekistan during its transition period. The management of all material flows take a major role in two important tasks: first achieving society's priority objectives by extensive access to grain and energy products and development of economic performance of the country by increasing industrial base and export commodities.

However economic development and increase of industrial base caused in growth of resource consumption accompanied with waste and pollution to the environment in Uzbekistan. Due to that we suggested to employ integrated system for sustainable production and consumption in Uzbekistan emphasis on sustainable and effective management of resources in medium and long term prospective.