Supporting Strategy for Urban Development and Housing Construction in Developing Countries regarding Global Climage Change (Abstract of the Final Report)

Contact person Hideyuki Kobayashi
Research Coordinator for Housing Information Syste,
Research Center for Advanced Information Technology,
National Institute for Land and Infrastructure Management
Asahi 1,Tsukuba, Ibaraki,305-0804 Japan
Tel:+81-298-64-4433 Fax:+81-298-64-0565
E-mail: kobayashi-h92qa@nilim.go.jp

Total Budget for FY2004-FY2006 38,244,000Yen
(**FY2006**; 10,645,000Yen)

Key Words Urban Development, Housing Construction, Developing Countries, CO_2

1. Introduction

Global Environmental Problems, including Green House Effect caused by CO_2 emission, are important and urgent issues, which should be solved for the purpose of achieving sustainable development, through co-operation among both developed and developing countries.

In this research, finally, we are going to propose appropriate urban form in the end of 21th century, and strategies for supporting efforts for achieving that urban form.

The appropriate urban form will both consider the impact from Global Climate Change (e.g. Sea Level Rise, due to Global Warming) and impact to Global Climage (e.g. Emission of Green House Gases), with regarding the basic needs for safety, health, comfort and affordability, etc. as conventional issues of urban strategy.

As a background, in 1999, Building Research Institute (BRI), Ministry of Construction conducted a feasibility study for "Global Environmental Impact Study of Urban Development and Housing Construction in Indonesia" funded by Environmental Agency.

Partially based on this result, the research project of "Integrated Impact Assessment of Sea Level Rise and Adaptation" (2000-2002, funded by the Agency, since2001 Ministry of Environment) was organized, headed by Geographical Survey Institute, Ministry of Construction (in 2001 the Ministry was re-organized into Ministry of Land, Infrastructure and Transport), and BRI (since 2001 NILIM) undertook the sub-theme of "Coastal Urban Area" in co-operation with Research Instite for Human Settlements, Ministry of Public Works, Indonesia and we have jointly conducted the 4 times of seminars/workshops to discuss and disclose the results in Bandung. The result was published from NILIM in English[(1)].

In the first fiscal year 2004, basic data were collected, which are needed for evaluating existing towns and alternatively planned future urban forms, through provision of macroscopic data through satellite image analysis and GIS data processing. For this purpose, 13 planned housing complexes in 7 cities were surveyed in Indonesia. 900 samples of detached houses are monitored from viewpoint of (1) amount of building materials, (2) domestic consumption of fuel and electricity, and (3) modes and trip distance of transportation. Also, production and transportation of major building materials were

monitored through factories, including red brick, timber, cement, ceramic tiles etc. Several important housing complexes were also analyzed from macroscopic view, through satellite image analysis on GIS.

In the following yeasr 2005-2006, two cities are selected for case studies for designing alternative future urban form. Cirebon is a coastal city, with flat land with humid and hot climate. Bandung is a inland city at altitute of 700-800m from sea, with slopy land and cool climage. Specific site for model design was selected from each city, and existing conditions (land, inhabitants and existing houses) are surveyed. In cooperation with local architects and city planners, four alternative plans were elaborated for each area, considering reduction of building material consumption, saving domestic energy and promoting public transportation and footpath. Greenery (urban fores), which is an important characteristic of tropical cities, was also promoted. Each alternative design was evaluated from viewpoint of not only reducing CO_2 emission, but also absorbtion of CO_2 by urban greenery and stock of carbon.

Those alternative designs were presented and evaluated in workshops held in March 2007, participated by local inhabitants, and resource persons including ones who are not experts of architecture and city planning, in order to discuss the feasibility of proposed plans and designs from viewpoint of social and cultural aspects.

2.Research Objective

The final target of this research is to proplse future urban form and housing style. In order to achieve it, this research follwed steps, shown in the flow chart.

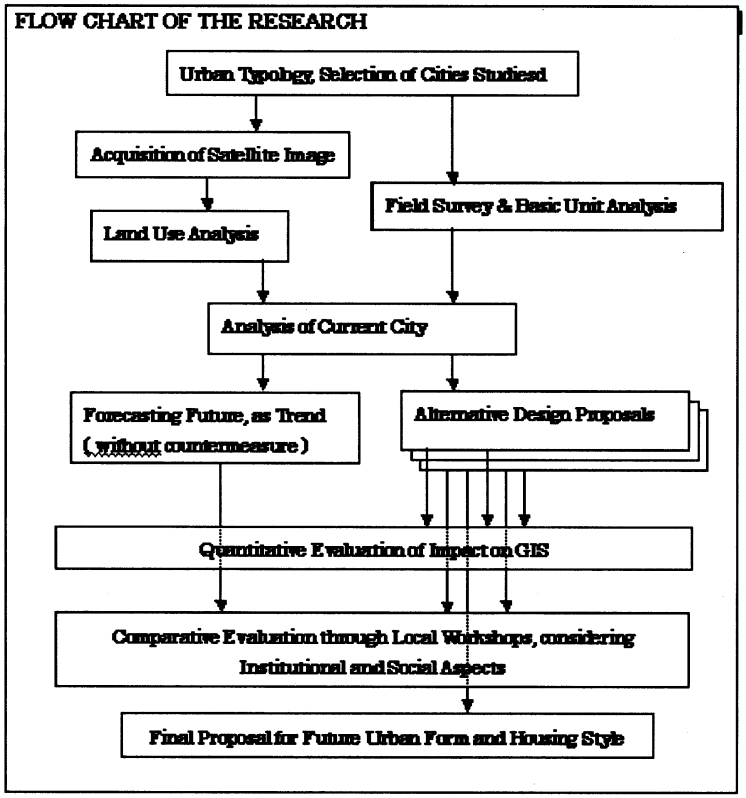

Fig.1 Flow Chart of Total Activities

3. Research Method

The basic methods for this study are conventional field surveys using questionnaire, and

designing by architects and city planners, and discussions in workshops and seminars. Field surveys for identifying the emissions from existing housing area were carried out 13 housing complexes from 7 cities in Indonesia, by survey teams organized by Research Institute for Human Settlements, Ministry of Public Works of Indonesia, selecting totally c.a. 900 samples of houses, in order to evaluate the emission caused by consumption of building materials, household energy, and transportation. These complexes are "new towns" with guided urban development, designed by architects and constructed by formal developers. The data obtained were analyzed to provide basis for evaluating designs for future. Two sites from two cities, Bandung and Cirebon were selected for model planning for future urban form and housing style. We created 4 alternative plans and designs for each site. These were presented to the participants of workshops, most of whom were not expert on architecture and city planning.

From viewpoint of research method, two innovative technologies are successfully tried in this research:

(1) Satellite image analysis on GIS basis

Conventional field surveys undertaken in developing countries are usually based on un-precife field maps, which eliminate the accuracy of the data obtained. In order to improve this condition, we utilized satellite image with high resolution to identify the survey area. Also green coverage ratio was measured by statistically analyzing the multiple band data. In order to improve this situation, we utilized satellite image with high resolution to identify the survey area. Also, green coverage ratio, which is difficult to measure through field surveys, was measured from satellite image, through statistically analyzing the multiple band data refering to canopies of trees.

In addition, recently, three dimentional data of land shape became available through analyzing stereoscopic satellite image provided by the PRISM sensor installed in ALOS satellite of Japan, which can obtain not only straight angle, but also inclined view angles to front and back, therefore every objects on earth can be seen from 3 different angles. We could successfully obtain 3d shape of ground of Cirebon and Bandung cities with enough resolution. Therefore, we could utilize this new material for planning.

(2) Usage of VR for desig and presentatio In developing countries, it is important to provide medias in order to present the contents of planning and design, which are easy to understand. Simple drawings (plan, elevation or cross section) are difficult for local people to understand. For this purpose, virtual reality is a choice, which show 3d data of planned towns and designed houses as if they were in front of us. Especially, in this study, the planned objects could be quite different from what are usual in current townscape.

For this purpose, a free software developed in Japan "LSS" was improved to be multi-language version, so that 3D data can be operated and presented on PC's in Indonesia on local language basis. All the menues, messages and help texts are translated into local language, by translators who are not professional for computer programming.

4. Result

Results from the 3 years activities are listed as follows:

(1) Current emission from Indonesian housing area was identified as follows:

Emission by usage of domestic fuels and electricity varies between 1,870-2,390 Kg-CO_2/Household/Year among averages in 7 cities surveyed. Usage of fuels is rather constant, while consumption of electricity widely varies, with relation to income of the households. This implies that consumption of electricity will rapidly increase in future including usage of air conditioning. This suggests the importance of heat designing of houses, through either efficient usage of air conditioning or comfortable natural air

ventillation is soak for.

As for transportation, emission comprises between 751-1,455 Kg-CO_2/Household/Year. This does not include usage of public transportation. Recently, motor bicycles are rapidly increasing. This suggests the importance of spatial arrangement of a housing complex that provide more convenient and comfortable usage of footpath and public transportation.

Life cycle emission from consumption of building materials varies 61-108 Kg-CO_2/Household/Year that is rather smaller than other items, assuming that average length of life is c.a. 15 year. Most major materials, e.g. timbers, roof tiles and bricks, are biomass based. Therefore, these are not counted. It is rather curious that the contribution of ceramic tile is large, because much petroleum is burnt for producing them.

Besides the Life Cycle Emission.of building materials, the effect of carbon stock in building materials was also evaluated. After the initial construction, average total floor area of surveyed complexes has been doubled through frequent extension and alteration of houses until today. However, average floor area within any comples has not exceeded 100 m2. It is estimated that a house comprising 90m2 of floor area keeps +3.4 tons of CO_2 in the form of timber, and –1.9 tons in the form of cement (totally +1.5 Tons of CO_2).

Distance of transporting building materials was also analyzed in Bandung and Cirebon cities.

(2) Precise geometrical/map data, that are usually unavailable in developing countries area, obtained from satellite image with high resolution (0.6 – 1.0m). Lahd shape was also analyzed from stereoscopic satellite image provided by ALOS-PRISM sensor, resulting DEM data with 10m of resolution, and 1m accuracy of altitude value.

(3) Green coverage ratio

Measurement of the rate of green coverage provided by canopy of trees (resulting biomass stock), through analysing the spectrum data of IKONOS satellite image, by using teacher data. Even in the Sarijadi area, where extension of individual houses resulted very high building coverage ratio, the value reached more than 10 %. This means that even the land for planting trees is very limited, the leaves will prevail over the roof, resulting high coverage ratio seen from above. This implies various spatial arrangement of greenery on the buildings.

(4) 4 alternative plans for each district selected from 2 cities with quite different conditions were elaborated. Each plan/design was elaborated by different architect/planner separately, and newly disclosed at the workshop held in March 6-7, 2007. Alternative plans (future image) for two districts are quite varied, including timber detached houses, or high-rise apartment houses. Site plans are also varied, including both cul-de-sac style and grid pattern. All the plans are considering the provision of greenery to be richer than existing site. A plan is promoting to plant at least one big tree in a courtyard within a houselot (Fig.1).

(5) Presentation of the alternative plans and discussions on them in workshops

Alternative plans were provided in the form of 3d data, and presented in the form of perspective views that are easier for participants to understand. The presentations were followed by discussions, and the presented alternative plans were finally evaluated by all the participants through filling the questionnaires. The participants consisted of representatives from each district, local government staffs, and resource persons from universities and research institutes.

5. Discussion

Within the workshop on Marth 6-7, after the presentation, various suggestions and opinions were disclosed from participants to the workshops. Amongst, experts of forestry,

explained that carbon sink (biomass) by tropical trees are far higher than default value of IPCC comprising 2.9 C-Ton/Ha/Year or 5.32 CO_2 Ton/Ha/Year. However, proposals for usage of timber have triggered contradictory discussions. Obviously, if usage of timber is accompanied with sustainable forestry business, then the usage of timber for building material will be evaluated as a form of longterm carbon stock. However, if the forestry business is only destroying the natural forests, then the usage of timber will merely accelerate the destruction process. At that time, governer of West Jawa province was promoting people to plant on the mountain. Apparently, small mountains near to the settlements in Bandung basin are covered with very poor forests. Therefore, if the local people really begin to plant again, then the effect will be great. Several kinds of trees, like Arbasia Falcata, or Acasia achieves very high performance of carbon sink, according to some resource persons of the workshop.

Highrise apartment was another key issue. In Indonesia, where earthquakes are frequent, high-rise buildings should consider the earthquake proof structure, requesting more expensive construction cost, driving urban form rather horizontal than vertical. However, consequently, the horizontal extension caused vast conversion of forests and agricultural fields to urban land use. Recently, against past trend, proposals for promoting constructing high-rise apartment houses are presented from the government. They are trying to construct 1,000 towers of 20 storeyed apartments.

High rise apartment will provide possibilities for greenery not only open spaces on ground, but also on walls or root top of building itself. Many variations could be designed. However, according some opinions, "living apart from ground" is not the Indonesian culture.

A question whether horizontal or vertical extention of cities has been the key issue in this country.

In Europe, high-rise apartments were tried in 70's, however abandoned since 90's because of the solemnity of elderly and prevailing criminals. Norther America followed this. However in Asia, starting from Hong-kong, Singapore, high-rise aprtment houses became a typical in quake free region. Korea and China followed this. Indonesia has just started to review previous horizontal extension of cities. In Feburuary 2007, Jakarta was attacked by flood that was larger than ever recorded. Considering the global warming which implies more frequent heavy rainfall, and sea level rising, Indonesian government decided to promote construction of high rise apartments, which will eliminate change of land use in urban fringe area.

In order to realize future plan, city planning accompanied with building regulation has not been more effective than urban development projects. However, financial intervention will be another alternative. Indonesian people are interested in "price". Therefore, for example, if the government get tax for materials that cause larger emission like cement, while giving subsidy to some lower emissive materials or some system for sink, like promotion of traced timer produced from sustainable forestry, the impact will be great.

These discussions in the workshop were triggered by 3D data of proposed alternative plans. If we discuss only cliteria for eliminating the emission at abstract level, then the contribution from the local people might have been less active.

Fig. 1 An alternative plan for Gunung District, Cirebon City

Reference

(1) HideyukiKobayashi, SitiZubaidah Kurdi: "Impact of Sealevel Rising on Coastal Cities – Case Studies in Indonesia- ", National Institue for Land and Infrasturucture Management, Ministry of Land, Infrastructure and Transport, August 2004 (287p)