

# **A Tool for Measuring Sustainable Capacity Development with Agent-Based Spatial Asset Mapping**

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**Key words:** Sustainable Capacity Development, Spatial Asset Mapping, Agent-Based Model

## **SUMMARY**

In the midst of increasing international awarenesses of functions and roles of capacity development (CD), there are growing concerns and questions about the mechanisms or relationships between CD and SD as to how the concepts and objectives of CD could achieve the goals of sustainable development (SD) within the context of sustainable capacity development (SCD).

While a model and framework of CD in international organizations would provide a comprehensive characteristics of core issues, functional capacities and point of entry (UNDP, 2006), there might be additional requirements for diverse perspectives of capacity's spectrums and demands in different organizations and societies. To further enhance existing methodology for measuring CD and improve capacity assessment framework, an agent-based model is creatively designed to expound the clues of harmonizations between CD and SD, and suggest an integrated solution for SCD.

In this study, a definition of sustainable capacity development is firstly articulated in international societies and its conceptual framework is also originally designed to assist concerned international organizations. Additionally, an agent-based spatial asset mapping is suggested to assist integrated surveying services. This study also elucidates the differences and similarities of capacity assessment between UN model and research results.

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## **1. INTRODUCTION**

An increase of human and organizational capacity or performance is recently growing issue in accordance with harmonization of sustainable economic, environmental and social development. It also aims to maximize developmental outputs and enhance organizational ability and societal process's roles.

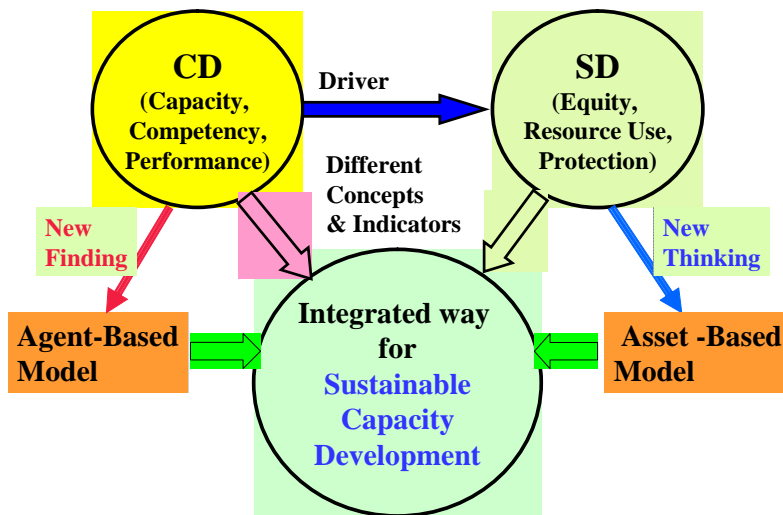
An appropriate method for measuring capacity building or capacity development (CD) has national and global intentions and awarenesses. Although many international organizations are making tremendous efforts on defining and measuring CD, their model of CD and assessment framework might not reach to the goal and objectives of sustainable development (SD). Existing international reports and documents have not yet suggested practical use of CD's concept for human well-being and better quality of life in sustainable manners. This paper elucidates how CD could be related with SD and what kinds of additional methods for CD and SD should be required for sustainable capacity development (SCD). To further ameliorate existing methodology for measuring CD and improve capacity assessment framework, an agent-based model is creatively designed to explain the clues of harmonizations between CD and SD, and suggest an integrated solution for SCD.

In addition, an agent-based organization and society is introduced to further support CD and SD because it is concerned with an agent model, organizational agent and agent society for simulating interactions and communications among agents. A conceptual framework for SCD and its definition are firstly articulated in international societies based on combinations between an agent-based model for CD and assets (or capitals) approach to SD. This study also scrutinizes disparities and similarities of CD between UN model and research results with regards to capacity measures, CD methodology and indicators, and GIS application to SD.

## 2. RELATED WORKS AND CHALLENGES

Many international documents and reports have put emphasis on describing definition, assessment framework, and importances of CD (DFID, 2003; GTZ, 2003; UNDP-GEF, 2003a, 2003b; WBI, 2004; UNDP, 2006). Considering controversial issues of capacity development (CD), CD is pertinent to ability, capability and competency to improve effective uses of existing resources, capitals and some valuable assets in sustainable way. CD is the process whereby individuals, groups, organizations and societies enhance their capacities in terms of human, organizational, institutional and social capital (Lavergne, 2004).

On the other hand, there might be lacks of understandings in expounding what CD implies in practical usages and applications for current requests of our well-being and how conceptual views of international CD could meet present needs of our sustainability. In this regard, there are critical argues and questions about the goals and initiatives of CD how it could play a significant role in improvements of SD.



**Fig. 1** New design for CD and SCD

Fig.1 shows a significant diagram for CD and SD, respectively requiring an agent-based model and asset-based model. An agent-based model approach to CD designed by (Liou, 2006) explains that an agent is concerned with different natures of people, things, associations, organizations and societies that have goal-oriented properties and certain capacities, competencies, and performances. An agent would often mobilize his assets, capitals and resources to increase his capacity. There are, however, very little researches on

definite liaisons and associations between CD and SD. In addition, the concept of CD is not compatible with that of SD and each indicator has different shapes and questionnaires. These questionable matters could often lead to a new thinking and new finding method toward an integrated way for SCD. But, there might be no yet acceptable models and frameworks to portray real applications of CD in the context of SCD.

### **3. ELUCIDATING MECHANISMS BETWEEN CAPACITY DEVELOPMENT AND SUSTAINABLE DEVELOPMENT**

The goals and objectives of SD pertains to creating capacities for raising each person's well being, living standards, and quality of life. Several models and frameworks for SD are recently hinged on capitals (SIGMA, 2003) or resources that have adapted the traditional approach of Balanced Scorecard (Kaplan and Norton, 1996) in order to set up capacity or performance drivers and outcome measures. From the perspectives of asset or capital developments, CD approach to the triple bottom line of capitals could be well-linked. In other words, the stocks of assets or capitals possessed by individual and organizations are viewed as capacities that could be converted to goods and services which contribute to human well being.

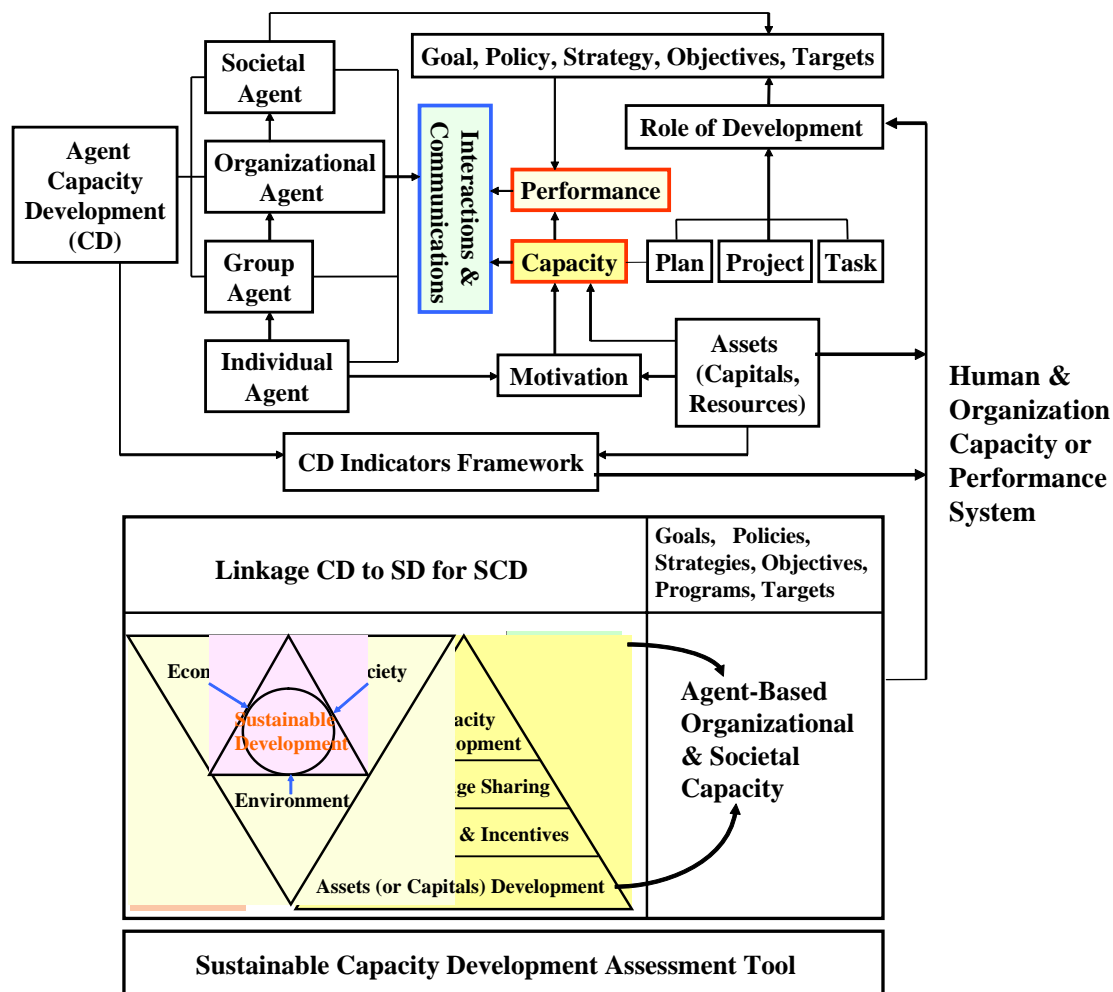


Fig. 2 Linkage's mechanism between CD and SD

On the other hand, CD is also linked to various policies, strategies, objectives and targets which seek to improve performance at different levels of organization and society. Thus, some aspects of CD could bring about diverse interpretations of capacity ranging from tangible things such as assets, materials, manpowers to intangible objects like skills, values, motivations, methods etc based on individual circumstances, organizational environments, and social policies and systems.

Therefore, a narrower definition of CD is based on assets or capitals that enable us to understand functions of assets (capitals, resources) and achieve significances of human capacity benefitting from uses and applications of several assets or capitals. Fig.2 illustrates that capital-based SD indicators distill into the frame of CD indicators. It starts with

inspections of indicator's compatibility that could assist with development planning of each agent. An agent understands that CD is considered as endogenous course of actions & long-term process of knowledge learning and sharing based on existing capacities and assets linking to agent's motivations and incentives.

As long as investments of tangible and intangible capitals are significantly considered as the primary engine of CD and SD, increasing and maximizing capacity and performance of agent-based organization and society may be now emerging national concerns and international focuses.

#### **4. AGENT-BASED ORGANIZATION APPROACH TO CAPACITY DEVELOPMENT**

Although there are no overall agreements on accepted and shared definition of agent, it would often be used for a computer science view of agency focusing on the characteristics of autonomous behavior. However, we use the notion of an agent for the representation of real human beings linking to their organizations and societies. Since the phenomenon of development processes and its outcomes are so complex, it is hard to analyze and estimate different types of agent's capacity and performance about efficiencies of his task and organizational structure.

With regards to an agent-based organization or agent society (Dignum, 2004), an agent-based organization would have considered as sets of entities regulated by mechanisms of social orders associated with organizational structure, purpose, rules and norms. An agent society is used in a similar way in human society or real world. In the course of dynamic economic activities and transactional interactions among agent societies, there are often profitable games for inevitable developments by capitals and resources between or among economic, environment and social parts. Obviously, a wide variety of types of capitals could play a major role in developments of human, economic, socio-cultural, natural, digital, physical, institutional and political features.

An agent-based organization consisting of small groups or individual agents, organizational and social model makes it possible to monitor their process's interactions and simulate task's capacities. Individuals, groups, organizations and societies may be viewed as goal-oriented or motivational associations that pursue their purposes, interests and desires.

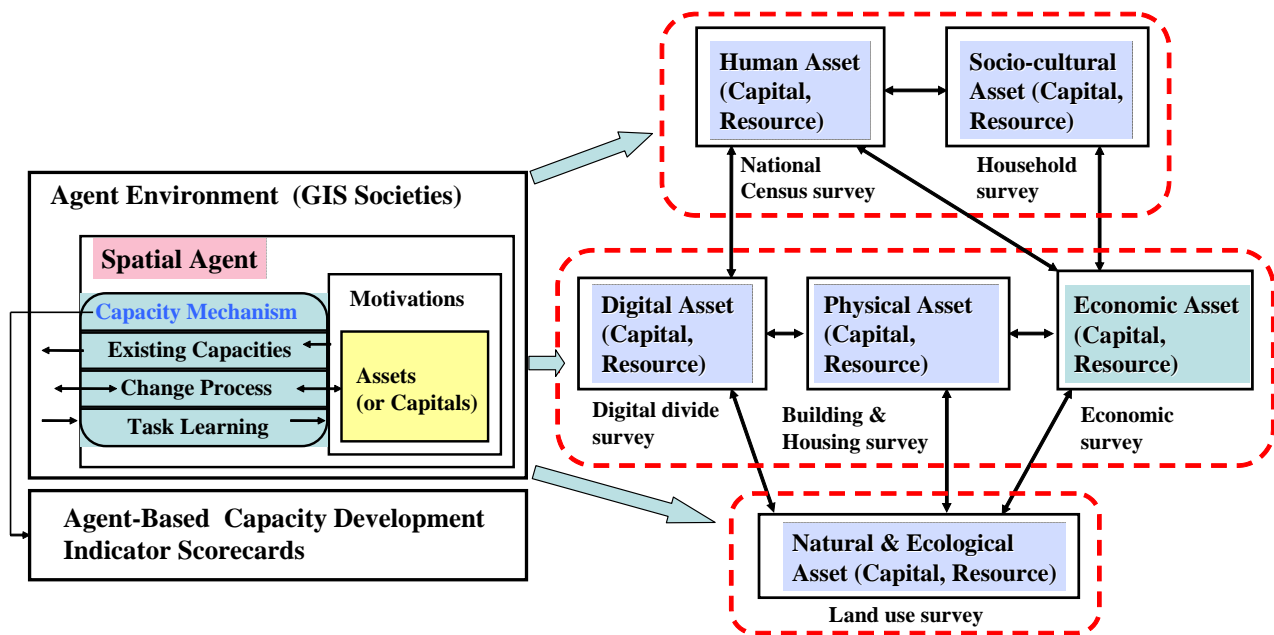
There are several types of agent architecture coming from logic-based, reactive, belief-desire-intention (BDI), and layered agent (Wooldridge, 1997). The concept of agent architecture could be applied to an agent-based organization such as an enterprise GIS organizations. But, organizational and societal capacity or performance are seriously impacted by internal and external interactions and relationships between and among agents. As shown in Fig. 2, CD could be implemented by coordination, collaboration, cooperation and resolution of conflicts in the process of interactions and communications of agents. More details of interactions to impact capacity or performance are problematic and are required for organizational and social agent model. But it might be beyond the scope of this study.

## **5. MEASURING SUSTAINABLE CAPACITY DEVELOPMENT USING AGENT-BASED SPATIAL ASSET MAPPING**

When recognizing real world's conditions and circumstances as to how agents can use assets (capitals, resources), individual and organizational agents strive to increase existing capacities and attempt to achieve motivational goals and desires in the context of capacity or performance system. In the process of CD, organizational goals, policies and objectives can be changed over time and the capacity for desired knowledge, skill and capital might be updated or transformed. As a type of BDI agents, spatial agent perceive capacity mechanism as the long or short term process of knowledge learning and adaptation to spatial environment's change. Spatial agent has been used for describing diverse agent's behaviors and activities in space.

Spatial agent is able to interact with other agents such as humans, institutions and a part of societal actors that complete his missions with specific individual or organizational motivations and approved capacities. Spatial agent acts to realize a set goals and objectives with existing capacities.

Fig.3 illustrates the relationships between an agent model and spatial asset mapping. A similar or different type of spatial asset mapping has been carried out by surveying and mapping agencies. Human and socio-cultural assets are associated with tasks of national census and household survey. Physical and economic assets are respectively concerned with tasks of real estate and financial banking survey. Digital asset is about the degree of universal access to telecommunication, Internet and mapping of spatial database. Natural & ecological assets are related to amenities of living qualities and ecological protections.



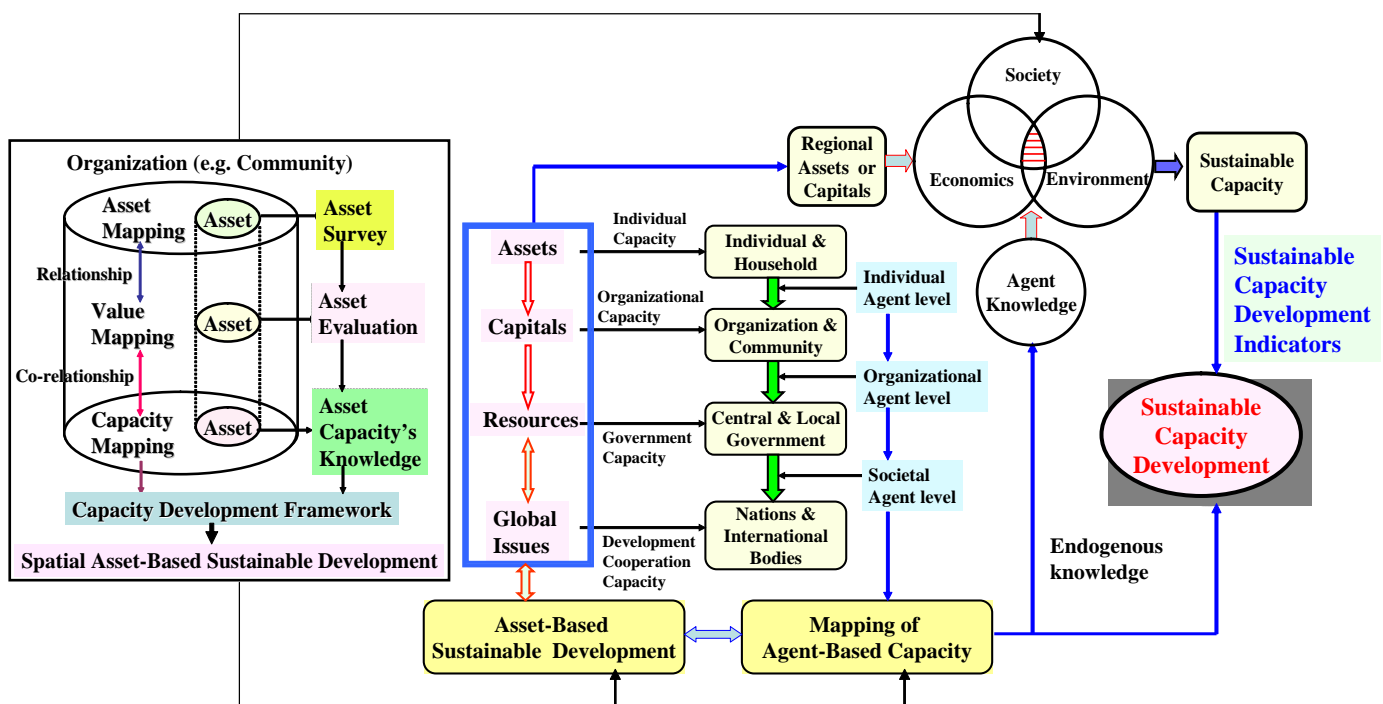
**Fig. 3** Agent-based spatial asset mapping for integrated surveying services

Here, there are some questions about which agent-based organizations are responsible for maintenances and improvement of concerned surveying and mapping in connection with SD. This also shows a feasible type of integrated surveying services if a dominant organization could establish technical and institutional service networks. There are, however, no clear explications or evidences how spatial asset mapping portrays an agent-based CD in conjunction with SD in space. Meanwhile, spatial asset mapping provides an analytical tool of asset's capacity for an interpretation of individual, organizational and communal sustainability when classifying and analyzing the strength and weakness of social, economic and environmental capitals.

Driven from Fig. 2 and 3, we could suggest a conceptual framework for sustainable capacity development (SCD) based on connections agent-based model for CD with assets (or capitals) approach to SD (Liou, 2006) shown in Fig. 4. The concept of agent-based capacity is closely pertinent to ownerships and selections of asset (capital, resource) that plays a bigger role in CD as a major enabler for SD. An agent-based capacity with regional assets (or capitals) could lead to sustainable capacity which endogenous agent knowledge is able to improve the capacity of SD.

In accordance with asset mapping, value mapping is expected to calculate values of

individual, organizational and societal wealths and belongings, and evaluate weaknesses and strengths of SD. Capacity mapping plays a significant role in some ideas on how policy-makers and planners could spell out their plan for sustainable community and regional development when comparing with current abilities and desired goals.



**Fig. 4** Agent-based spatial asset mapping for SCD

Here, sustainable capacity is considered as the ability and competency for an agent or agent-based organization to mobilize their assets, and use them for maintaining and strengthening equilibrium of sustainability. Therefore, SCD is defined as sustainable capacity for agent's ability (individuals, groups, organizations, systems) to perform their functions, ensure the better quality of life, and set and achieve objectives of CD through sustainable uses of assets, capitals, and resources.

## 6. CONCLUSION

The relationships between CD and SD are internationally emerging concerns, but very little researches have been focused. The purpose of this paper is to expound the way of linkage between CD and SD based on the center of an agent-based model. With the help of asset (or capital)-based SD, an agent-based model for CD is used to describe the origin of SCD and

explicate demands for an agent-based organization and society.

Since there are many various issues of capacity dimensions at 3 levels (individuals, organizations and systems), it might be hard to indicate a specific feature of point of entry (UNDP, 2006) when matching with core issues and crossing-cutting functional capacity. Thus, the concept of an agent-organization and society possessing assets (capitals and resource) is used for more clearly describing definitional capacity measures and CD methodology.

When comparing UN model with research model, Table 1 shows major disparities and similarities of CD and feasible supports for SD in conjunction with GIS. In terms of CD indicator scorecards, they use mostly qualitative methods. Thus, measuring SCD and visualizing CD in space are not yet considered.

	UN Model	Research Model
<b>Definitional Capacity Measures</b>	<b>Ability of Individual, Organization &amp; Society</b>	<b>Asset (Capital)-Based with Selection Theory</b>
<b>CD Methodology</b>	<b>Logical Model</b>	<b>Agent-Based Model</b>
<b>CD Indicators</b>	<b>SMART (Specific, Measurable, Attainable, Relevant, Timebound)</b>	<b>Capacity of Assets and Agent's Ability</b>
<b>Capacity Assessment</b>	<b>Points of Entry, Core Issues Functional Capacity</b>	<b>Asset, Value, Capacity (Mapping)</b>
<b>Applicability</b>	<b>Static &amp; Limited</b>	<b>Dynamic &amp; Practical</b>
<b>Support for SD</b>	<b>Unidentified</b>	<b>Full support</b>
<b>Connection with GIS</b>	<b>No Linkage</b>	<b>Spatial Agent</b>
<b>Support for SCD</b>	<b>No Linkage</b>	<b>4D Spatial Asset Mapping with ABM</b>

**Table. 1** Comparison between UN model and Research model

Meanwhile, research model is hinged on integration of an agent-based model and spatial asset mapping enabling to provide more tangible measures and solutions for SCD. This research model is also designed to support sustainable community development and community capacity building. Considering international awarenesses and urgent needs for integration of CD and SD, spatial asset mapping is particularly designed for measuring SCD connecting an agent-based model for CD with asset-based SD.

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