AÏDA – Providing a framework for objective assessment of ICT for Disaster Risk Management in Africa

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ABSTRACT

As part of its recently renewed interest in Africa, the European Commission has funded the 2-year project "AÏDA - Advancing ICT for DRM (Disaster Risk Management) in Africa". AÏDA is primarily an inventory of the ICT situation in Africa – at continental, regional and national scales – to guide European funding decisions in R&D and capacity building in Africa. The first project objective was to develop a conceptual framework for the assessment of ICT for DRM, to serve as the basis for the in-depth regional and detailed studies in 4 countries. The purpose of this paper is to provide an overview of the structure of this CF and its principal findings. By evaluating existing ICT achievements that are or can be applied towards DRM, but also limitations and bottlenecks, the CF can also guide governmental or non-governmental agencies focusing on DRM in Africa, as well as to target research efforts.

Keywords

AÏDA, ICT, Disaster Risk Management, Africa

INTRODUCTION

Natural disasters are continuously increasing in number globally, and there is agreement that (i) vulnerability is rising worldwide, (ii) economic damage and the number of affected people are continuing to increase, and (iii) that disasters constitute a severe impediment to economic growth. This is especially true for developing countries, which have suffered more than 90% of all fatalities, and have been disproportionally burdened by the economic losses as well, due to, amongst other reasons, their lower GDP, limited reserves, and an under-developed insurance industry. While Asia has been confronted with the largest absolute number of annual natural disasters, Africa has seen the most rapid increase in recent years (Figure 1; CRED, 2008). While better reporting certainly plays a role in this statistical increase, also the underlying causes of disasters – the intersection of hazards, vulnerability, and elements at risk – have changed. Population growth in Africa now exceeds that of all other continents, exposing vast numbers of additional elements at risk (EaR) to the existing hazards. At the same time, persistent poverty, as well as lacking access to adequate education, health care, financial resources and political power, continue to maintain widespread vulnerability. Of the 177 countries listed in the 2007/2008 UNDP Human Development Report, of all African countries only Libya and Tunisia managed to score amongst the first 100 countries, with 35 listed in the final 50 places in terms of GDP (UNDP, 2008).

The relatively strong increase in natural disaster numbers in Africa may also be attributed to the relative lack of interest in the continent by extra-African governments and media. This, however, is a situation that has been changing in recent years, for several reasons. China has been attracted by the vast resource base with relative ease of access to sustain its economic growth. For the US it has been a mixture of ideological battleground, e.g. attaching ideology-guided conditions to aid and assistance, and renewed scientific interest, in particular by the USGS and NASA. Lastly, also with the aim of maintaining and extending influence and relevance on the continent, as well as to reduce future numbers of people heading towards Europe, the EU has increased its attention, primarily with funding for research and education, an example being the push for a *GMES for Africa*.

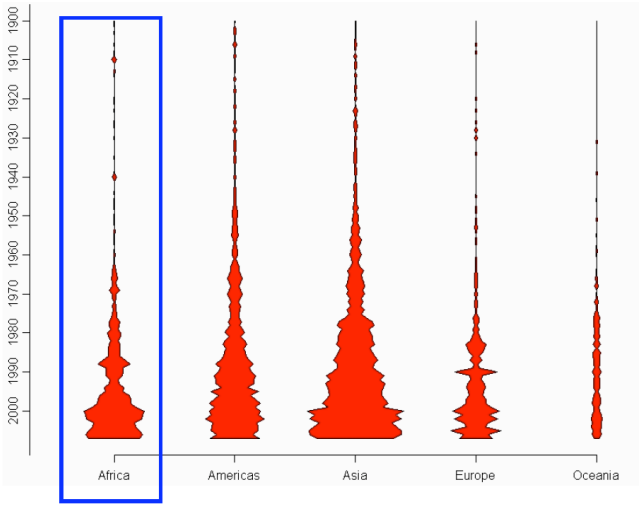

Figure 1. Number of reported natural disasters between 1900-2007 per continent, with Africa showing the strongest increase (CRED, 2008).

Amidst this surging interest renewed attention has also been placed on Disaster Risk Management (DRM). However, while the statistics on disaster incidence appear to be comprehensive for nearly all countries, understanding the actual risk as a prerequisite to reducing it lastingly remains challenging. Africa is exposed to all major hazards also afflicting other continents, as well as several endemic ones, such as Rift Valley Fever. Many of those have been well mapped in terms of the areas potentially exposed to hazardous events, and their potential severity and return periods. Thus continental or regional maps exist for all major hazards. However, far more information is needed to understand multi-hazard risk at spatial scales suitable for intervention. Africa is a quilt of ethnicities with substantial geopolitical and geographic variability, and still typically seen as a continent where the focus must be on keeping people alive and defusing conflicts. Thus little progress has been made in DRM that accounts for the large variability in hazard types, spatial scales, and thus disasters that range from rapid, local events, to regional, long-lasting events, and those that lead to repeat or secondary disasters.

As part of its 7th Framework Program, the European Commission (EC) approved the 2-year project "AÏDA - Advancing ICT for DRM in Africa", which commenced in mid-2008. AÏDA is primarily an inventory of the information and communication technologies (ICT) situation in Africa with respect to DRM – at continental, regional and national scales, the latter in 4 selected countries. One of its initial goals was to develop a conceptual framework (CF) for the assessment of ICT for DRM, to serve as the basis for the in-depth regional and country studies. The purpose of this paper is to provide an overview and summary of this CF in the context of AÏDA.

AÏDA is primarily meant to advise the EC on the status-quo to allow better targeted funding for R&D as well as capacity building (CB) projects. However, as the project also addresses in detail which limitations need to be addressed where, it can serve guidance for governmental or non-governmental agencies focusing on the DRM field in Africa, as well as to target research efforts. However, as it also highlights the many achievements – policies in place, observation networks, satellite infrastructure, existing early-warning systems or CB programs, that show that much has already been realized that can be built on, and allows the targeting of existing programs with which to liaise or which to support.

The following chapters introduce the focus, scope and layout of the AÏDA project, detail the role of the CF and its structure, and summarise the main findings of the report, including their significance outside AÏDA.

THE AÏDA PROJECT

The AÏDA project aims at inventorising and sharing knowledge about suitable and affordable ICT solutions in Africa with the ambition to reduce the risk of natural disasters and to improve the capacity to respond to disasters. It will include a survey of existing approaches and capabilities, to what extent they work or not, and how they can be improved and implemented elsewhere on the continent, as well as an evaluation of other suitable ICT means, including those originally developed for other fields. In short, the AÏDA project will:

- inventorise existing natural hazards, past disaster events and trends, and disaster risk to the extent known in Africa;
- assess the role of ICT based systems in each hazard category;
- explore affordable ICT means and trends, as well as future needs, for sustainable DRM in Africa;
- study in depth the situation in 4 different countries with a focus on different hazards: wild fires – South Africa; tsunamis – Tanzania; drought, locusts and food security – Mali; and epidemic hazards (e.g. bird flu and malaria) – Nigeria;
- test the utility of GEONETCast, one of the main technical vehicles of the Group on Earth Observation (GEO), as an alert system;
- share this information with all DRM stakeholders in Africa (by workshops and other means);
- prepare 3 showcases of operational African DRM systems for demonstration during these workshops;
- promote and support the take-up of this technology for use in other disaster types; and
- liaise with any new project in DRM with a significant involvement of African partners.

AÏDA is explicitly not meant to develop expensive, western-based solutions, but rather identify what is already being developed or applied on the continent and can be transferred to other countries or regions, or extended to cover more hazards. Cooperating closely with the African Association of Remote Sensing of the Environment (AARSE), EUMETSAT, as well as the University Network for Disaster Risk Reduction in Africa (UNeDRA network), it comprises 10 project partners in Africa and Europe.

THE AÏDA CONCEPTUAL FRAMEWORK

AÏDA addresses the concepts of ICT in the framework of and with relevance to DRM. While the former can, at its simplest, be defined to encompass all technological and conceptual means to acquire, process and communicate information, defining DRM has proved more troublesome. Thus, given the large number of project partners and associated organizations, the first objective, and the focus of this paper, has been to devise a comprehensive CF, aimed at the following:

- to summarise what is known about natural disaster occurrence, historic developments and trends, and about scales, frequencies and consequences of disaster events in Africa, as well as about hazards and risk;
- to provide clear conceptual definitions for such a multi-scale, multi-hazard study, including terminology and evolution of DRM theory, to be done as a synthesis of hazard and risk research history and development, and deriving the most recently developed and used concepts;
- to analyse which international DRM policy efforts affect Africa, and to what extent they hold potential for the continent (such as the Hyogo Framework for Action [HFA] or the International Strategy for Disaster Reduction [ISDR] (2006));
- to review Africa's own DRM policies and Disaster Risk Reduction (DRR) strategies;
- to analyse the current ICT capabilities of relevance for DRM in Africa, including trends and limitations;
- to investigate which international ICT efforts are directed towards or include Africa; and
- to evaluate which ICT efforts have originated in Africa, and which trends and plans exists.

Thus AÏDA serves to draw a detailed and objective picture of the current ICT for DRM situation in Africa, to lay out both existing capabilities and promising developments, but also the scale, and where possible, reasons for limitations. The CF was initially only devised as a basis for the regional and country studies that form the core of AÏDA, to ensure that a homogenous picture – in terms of concepts and terminology used – emerges. However, it also serves as a standalone inventory of the disaster risk situation at continental and regional levels, current technical possibilities and limitations, international political frameworks being join or new ones being set up, and existing and emerging data and information generation, processing and transfer means. This is of equal relevance to governmental and international bodies, as well as NGOs and the scientific community focusing in Africa, as it

identifies champions to work with, bottlenecks to be removed, partners best suited to work with and networks to be joined. It is hoped that the report, and AÏDA as a whole, will not only guide the EC's decision making on how to proceed with DRM-directed ICT efforts in Africa, but that it will also be taken up by other actors focusing on Africa. This can help avoid redoing the analysis work, but will also work towards a more homogenous use of concepts and terminology. The CF will be further developed and expanded throughout the AÏDA lifetime, scheduled to be complete in mid-2010, to integrate the results from the ongoing in-depth regional and country studies. Currently standing at about 100 pages, the CF can be requested from the AÏDA consortium.

Structure of the CF

The CF is organized along the following main headings:

1. Objectives and scope of the Conceptual Framework
2. Natural disasters in Africa
3. Disaster management conceptualized
4. The scalability of risk
5. The hazard situation in Africa
6. From hazard to risk
7. Disaster Risk Reduction policies and strategies
8. The role of ICT for DRM in Africa
9. International ICT-based DRM efforts directed towards or including Africa
10. Tools for information transfer and use – beyond the internet
11. African ICT initiatives
12. Summary
13. Acronym list
14. References

As AÏDA is an ongoing project more headings may be added as necessary, and all findings from the other work packages, in particular the regional and country studies will be integrated.

Main findings and observations

Being essentially a desk study, the CF is a synthesis of a large amount of literature (resulting in a comprehensive bibliography), coupled with results from previous research and CB by AÏDA partners on the continent. The following are the main findings and observations of the CF, related to (i) hazards and disaster, (ii) risk, (iii) DRR strategies, and (iv) ICT solutions:

Hazards and disasters

- Africa has shown the highest growth in disaster numbers of any continent.
- It also shows the highest population growth, resulting in more elements at risk, more pressure on resources, and thus a high probability of rising vulnerability and hazard exposure, the latter by more marginalized people being forced to move into hazardous areas.
- Hazards and disasters show regional patterns, linked to structural geology (seismic and volcanic), circulation patterns, etc. Understanding of those underlying causes will help to understand hazard better, especially in terms of their frequency and magnitude. The CF gives a detailed portrait of 10 major hazards largely the continental, at times also at regional scales, and includes geo- and hydrometeorological hazards, but also addresses grasshoppers and locusts as well as epidemics.
- Much is known about the hazard situation in Africa, the result of much dedicated research and monitoring, often by international organizations, but also efforts of African scientists and organizations. However, many hazard types are easily summarized but in fact have many different facets, each with its own scale and hazard characteristics. Extreme examples are seismic hazards where areas likely to experience shocks of a certain magnitude are quite easily identified, while local results are more a function of soil type and thickness that determines liquefaction potential. Also volcanoes pose many hazard types with effects that range from very local to global. Hazards can be highly dynamics in space and time, may be entirely of natural origin, other are increasingly man-induced or amplified.

- Essentially all hazards at regional to country level are already being effectively monitored by existing initiatives. However, more detailed monitoring at sub-national level, in particular reflecting the specific local hazards, is needed. For some hazards, such as meteorological, existing data from Meteosat Second Generation (MSG) suffice, with only local technical capacity building being needed to produce local weather products. For other hazards, e.g. seismic, changes in methodology are needed for seismic microzonation at local levels.

Risk

- Disasters are primarily a social phenomenon, linked to high vulnerability and limited capacity (Wisner et al., 2003). ICT must address these aspects, e.g. via education and capacity building, early warning, but also community involvement.
- Risk may include a number of hazards that interact or even compound each other. Only a thorough understanding of the multi-hazard risk situation, one that also considers the different types of vulnerability, will allow effective and sustainable DRR.
- Quantification of risk is challenging as units vary or a ready assignment, such as a monetary value of life, is not possible. Thus agreement is needed on risk units to ensure comparability (Ebert et al., 2009).
- Different means exist to assess risk, ranging from more qualitative approaches, often including community participation, to quantitative, GIS-supported techniques.
- Hazards may have broad patterns and may thus be efficient to monitor with ICT, in particular space assets. However, vulnerability is an inherently local phenomenon. Thus if regional risk assessment is carried out, the limitations of such approaches must be understood. Ideally risk is assessed and reduced locally. Risk is fundamentally scalable, only defined by the probability of loss of or damage to lives or assets through a hazardous event. Thus the risk concept, e.g. hazard or vulnerability reduction, as well as capacity increase, leading to reduced risk, holds true at all spatial scales. It applies to a family with vulnerability resulting from a single piece of livestock constituting the family's asset, but also a country with a vulnerable population being exposed to a drought or flood hazard.

DRR strategies

- African DRM is already well linked in at a broad conceptual level, with international DRM strategies. The African Union has adopted international strategies (e.g. the HFA) – the priority now must be to carry what is known about DRR to national and local levels, and to link it to all ongoing sustainable development efforts.
- Everything that works towards reducing poverty, safeguarding the environment, or otherwise achieving the Millennium Development Goals of the UN will also reduce the risk situation as it reduces vulnerability and/or increases capacity.
- With DRR being a global concern, many countries have developed effective monitoring, early warning and DRR strategies. However, a simple transfer of those approaches likely will not work as important differences exist in Africa, especially with respect to infrastructure, but also in terms of culture. Far more effective than a technological solution can be to educate, promote and support a local champion, one who can assist a community in making the right decision when faced with a hazardous situation. Acceptance of centralized DRR ideas may also only be possible via community-involvement.
- A convincing demonstration of simple yet effective means to reduce multihazard risk can be implemented, e.g. how the cleaning of ditches and canals can reduce malaria, flooding and intestinal disease. Only broad acceptance and ownership by the community will lead to the needed local support.

ICT solutions

- Many data types, especially those derived from spaceborne remote sensing, are useful for different purposes, thus multi-use to increase efficiency is useful (Kerle et al., 2008, Zhang and Kerle, 2008). GEONETCast was identified as a novel, versatile and low-cost means to access geospatial data from a range of monitoring projects at any place in Africa, even where no traditional communication means exist (Maathuis et al., 2008).
- An increasing emphasis on open source and free software tools for data access, processing and modeling means that, together with the many free datasets available via the internet or GEONETCast, even organizations with very limited budgets can now carry out DRM-related data processing. The remaining bottleneck – limited human capacity – should receive much stronger attention, as only then the available technical means can be utilized.

- Africa itself has shown strong technical capacity and readiness to participate on advanced ICT-based DRM solutions. Four countries have already operated space technology and invested heavily on human and technological capacity to further these developments. What is needed is stronger international cooperation, where also countries without such technology but that share common hazards and risks can benefit. Still too often DRM is seen as a purely national endeavor.
- Of particular interest is the way telecommunication has been developing in Africa, with technological leapfrogging leading to widespread mobile phone use, at the expense of absent traditional landline systems. Internet penetration, in particular broadband access, is also being very limited, and DRM approaches need to reflect this. GEONETCast has been shown to be a suitable manner to get large datasets timely and economically to all African countries without the need of extensive internet infrastructure (see also below).

Disasters result in a variety of consequences, some being characterized by high fatality rates (e.g. seismic events), others by widespread economic damage (flooding, drought), and differing also greatly in spatial and temporal extent. With limited means for DRR, a prioritization is needed, and best based on a risk assessment that reflects the true overall potential cost. Care must thereby be taken to interpret statistics correctly. Figure 2 shows how the distribution patterns for fatalities and for affected people can differ. Thus mapping either the number of affected or killed people for a given hazard type will result in fundamentally different maps, a fact to be considered in resource and priority allocation.

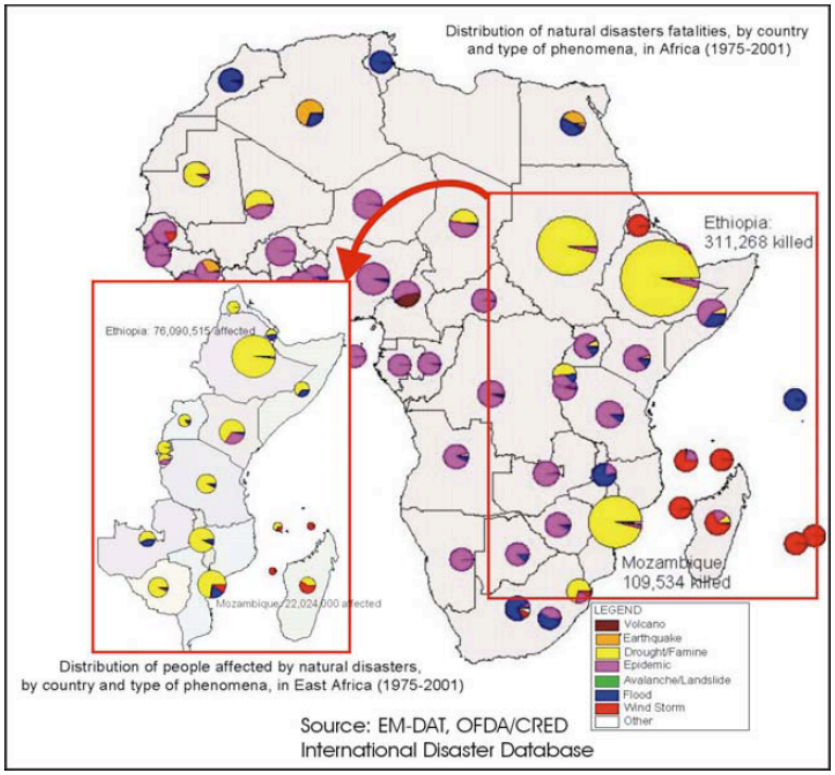

Figure 2. Number of affected people per hazard type in Africa, with inset showing the number of fatalities for the Eastern part of the continent, 1975-2001 (CRED, 2008)

CONCLUSIONS

The purpose of the AÏDA CF was to review the concepts of DRM, define all relevant terms, to assess the hazard, risk and disaster situation in Africa, to introduce global initiatives aimed at DRM support on the continent, to discuss the role of ICT in Africa, to inventorise international hazard and early warning systems that include or focus on Africa, and to highlight ICT initiatives that originate on the continent itself. The sheer size and variability of the

continent, and the scale-dependency of hazard, vulnerability and risk, result in a situation where an inventorisation by necessity must have limitations. Aimed at setting the stage for the in-depth regional and country-level studies that form the core of the AÏDA project, only the overview of previous disasters includes the country scale. All concepts and initiatives related to ICT were only reviewed and discussed at continental to regional levels.

The review of the disaster situation showed that Africa is seeing the largest increase in disaster numbers of any continent, but also highlighted regional hotspots and patterns. Emphasis here was placed on the need for correct interpretation of disaster statistics. DRM, not just in Africa, requires a sound and consistently used conceptual framework, in particular one that incorporates the concept of multi-hazard risk. The CF makes clear how risk, as a function of hazard, vulnerability in its various forms, and capacity, can best be reduced and can thus serve as a basis on which to decide how to spend limited resources to reduce local risk.

The CF reviewed which international DRR strategies exist to provide conceptual approaches and practical networks, and highlighted the limited telecommunication means in Africa as a serious bottleneck in DRR, in that they prevent ready access to the vast amount of risk-related data and information, as well as networking and collaboration of African institutions amongst each other and with those outside the continent. However, it also showed how unique approaches, such as a the leapfrogging straight to mobile telecommunication (Figure 3A), also offer hope that communication and information provision to most populated places in Africa via mobile phones will soon be possible, even without widespread internet access (Figure 3B) where needed aided by direct satellite reception as offered by GEONETCast. Lastly, it was shown that Africa itself has brought about a range of regional DRM initiatives that are conceptually and technically sound, and well linked in with related international network and initiatives, thus reflecting the spirit of the Global Earth Observation System of Systems (GEOSS).

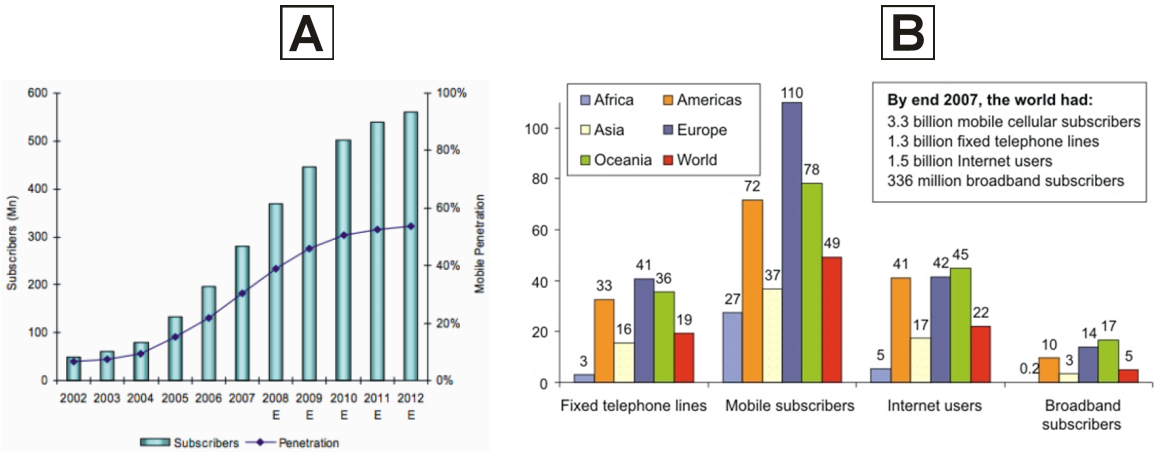

Figure 3. A - Mobile phone subscriber numbers and penetration between 2002 and 2012 in Africa (Source: African Mobile Factbook, 2007). B- ICT penetration rates for 100 inhabitants in 2007 (Source: ITU World Telecommunication/ ICT Indicators database, 2007).

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REFERENCES

1. CRED (2008) EM-DAT: The OFDA/CRED International Disaster Database.
2. Ebert, A., Kerle, N. and Stein, A. (2009) *Natural Hazards*, 48, 275-294.
3. International Strategy for Disaster Reduction (ISDR) (2006) Disaster statistics 1991-2005.
4. ITU (International Telecommunication Union) (2007) *World Telecommunication/ICT Indicators Database*. Geneva: ITU.

5. Kerle, N., Heuel, S. and Pfeifer, N. (2008) Real-time data collection and information generation using airborne sensors. In: Geospatial information technology for emergency response (Eds, Zlatanova, S. and Li, J.), pp. 43-74. Springer.
6. Maathuis, B. H. P., Mannaerts, C. M. & Retsios, V. (2008), ITC Geonetcast - toolbox approach for less developed countries In: Proceedings of the XXI congress, 3-11 July, Beijing, China. ISPRS, 2008. pp. 1301-1306.
7. Telecom-week (2007). African Mobile Factbook 2007, Blycroft Publishing, http://www.africantelecomsnews.com/Factbook_form.html
8. UNDP (2008) Human development report 2007/2008. (Eds, Nodvin, S. C. and Walser, M. L.), pp. 384. UNDP, New York.
9. Wisner, B., Blaikie, P., Cannon, T. and Davis, I. (2003) At Risk: Natural Hazards, People's Vulnerability and Disasters, Routledge, London.
10. Zhang, Y. and Kerle, N. (2008) Satellite remote sensing for near-real time data collection. In: Geospatial information technology for emergency response (Eds, Zlatanova, S. and Li, J.), pp. 75-102. Springer.