

## USING GEO-SPATIAL TECHNOLOGY TO FLOODING POTENTIAL MODEL IN GAL OYA RIVER BASIN

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### Abstract

Galoya River basin affected by flash flood during the north-east monsoon period. The Department of Irrigation, Metrological Department and Disaster Management Center to predict flash flood events. However, these programmes have a number of scarcities for several forecast areas in nation. Developing a GIS based model that integrates basin physiographic characteristics will allow the hydrologist to better predict flood events. In this study, I have developed geospatial model to establish the flooding potential for the upper Gal Oya river basin. The dynamic GIS parameters used to model development are slope and flow accumulation, land cover and vegetation, soil hydrologic, drainage classes and precipitation. All these layers were converted to raster datasets, using the basic attribute field responsible for flooding potential analysis each model parameter was assigned weights at the time of reclassifying, a rank of least flood potential (1) to most flood potential (9). Finally, each layers were overlaid with a weighted overlay analysis. For the weighted overlay analysis, each layer was given certain weights evaluated by their influence in flooding potential. The final flooding potential map was obtained as colored map with scale 1 to 9. This model can be easily simulated in any other basin in the nation by changing the input parameters. Study area under different flooding potential scale. More than 70% of the area is under the low to medium vulnerability with respect to flooding potential. Rest of is under high to very high flooding potential area.

**Key Words:** GIS, Spatial Analysis, Model Builder, Flooding Potential and Weighted Overlay

### INTRODUCTION

Due to global warming, the ocean's thermohaline circulation pattern is changing. It is known as an El-Nino and La-Nina effect. Therefore, the ocean surface temperature is changing geographically. As a result, unlike earlier time, more than usual precipitation is happening in several parts of the world (Panda, 2008). Flash flooding induced by sudden surged storm events has recently become a norm in the world (Lee and Lee, 2003; Hudson and Colditz, 2003). In this present decade, it is a fact that most of the national disasters in Sri Lanka are due to Flooding. 2011 flood in northern and eastern region are few examples. Therefore, reliable flood models are a necessity to allow emergency managers and city planners to obtain advance warning in severe storm

situations and get prepared for the eventuality (Knebl *et al.*, 2005). Flood inundation modeling would also help planners and insurance people to take major decision to safeguard public's interest (Bates, 2004). Geographic information systems (GIS) are currently being used to help model flooding potential and inundation. Robayo *et al.*, (2004), rainfall time series data with GIS in hydrological modeling. The Map-to-Map tool creates an ArcHydro model and an interface data model for all models that share data with GIS to output a floodplain map. Dyhouse, *et.al* (2008) have developed mechanism to model floodplain using HEC-RAS software. This study used the hydrodynamic modeling tool, which allows for a complete analysis of flooding impacts (Yang and Rystedt, 2002). However, all these software used to model

floodplain are cumbersome and sometimes difficult to work with. The NBRO and DMC currently use the Flash Flood Monitoring to predict flooding events. Within each hydrologic basin rainfall rates and accumulation is based on amount of reflectance. Then the average rainfall value is compared to the Flash Flood Guidance generating a flash flood index. When they venture into flood predictions in micro-watersheds, they face problem with basin connectivity and data authenticity. This study also have problem in identification of correct individual basin physiography.

Incorporating GIS into flash flood prediction will greatly improve the accuracy of the DMC warning system for any spatial area vulnerable to flash floods. Developing a geospatial model in ArcGIS ModelBuilder would also enhance the ability of layman with simple GIS know how to predict flooding probability in any area of concern. The preliminary GIS model contains intrinsic parameters of soil, vegetation, land cover, slope, and flow accumulation. Running a model based on these intrinsic parameters creates a static map of potential flooding. To make the map more dynamic and useful to the DEM precipitation data is added at the end of the model. The overall goal of this study is to generate a flash flood index ranging from least potential to flood (1) to greatest potential to flood (9) for Gal Oya River basin.

## MATERIALS AND METHODS

### Study Area

The study area for this paper is the Gal Oya River basin portions of Eastern region of Sri Lanka. It consists about 2000 sq.km and covered Mahaveli basin on the west, Maduru Oya, mundane Aru and Andalai Oya basin on the north, Ambalam Oya, pannal Oya, Karanda Oya, Heda Oya and Kumbukan Oya reven basin on the South and Indian Ocean on

the East (Figure 01). Eastern part of the site of the study area has high populated.

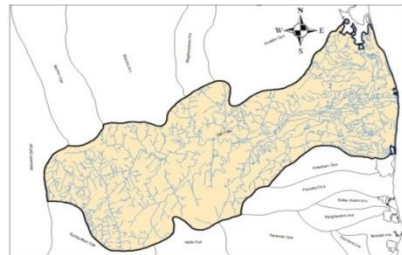


Figure 01: Study Area map of Gal Oya River basin

### GIS and other Data Layers Used in the Study

Raw data sets used in this study include basin Digital topographic map (coverage file -scale 1:50000), Department of Survey, Sri Lanka, Soil map (shape file), Land Use Policy Planning Department. The annual average rainfall data was collected from the rain gauges inside and the adjacent areas by Metrological Department.

### Spatial Layers Preparation for Analysis

#### Precipitation Data Preparation

Precipitation is a major player in flooding potential mapping (Chow *et al.*, 1988). With high annual rainfall, there is potential for more flooding. Therefore using precipitation data is essential. There were five gauging stations around the study area. The annual average rainfalls for these five rain gauges were 164, 187, 213, 251 and 272 mm, respectively. A point shape file was created in ArcGIS with the average precipitation value as an attribute in its attribute table. Then the 'Inverse Distance Weighted' surface interpolation technique was used to create an interpolation raster from the point shapefile. Thiessen polygon technique can be used to obtain the distributed precipitation data for non-recorded locations. Then the Extract by Mask tool was used to clip the precipitation raster to the study area (Figure 02 to 04).

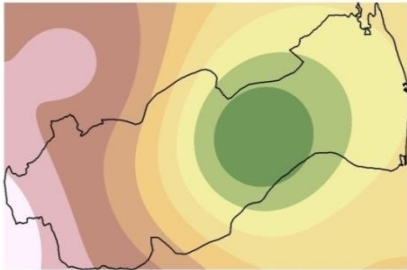


Figure 02: Interpolation Technique (IDW)

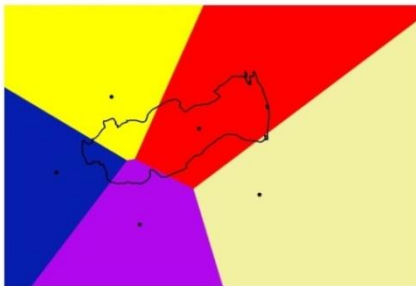


Figure 03: Thiessen Polygon Technique

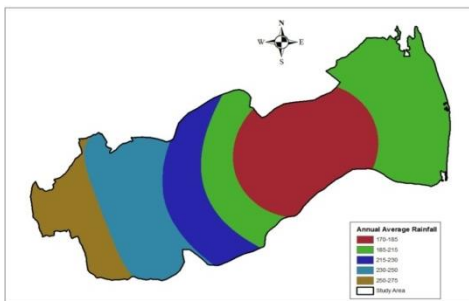


Figure 04: Reclassified Precipitation

Finally, the precipitation raster was reclassified into a scale of 1 to 9 with the class with the lowest rainfall amount getting a value of 1 and the highest one getting a value of 9. It was performed by classifying the

precipitation raster with Equal Interval classification technique with nine classes while performing the reclassification on the raster (Figure 04).

### Soil Data Preparation

Soil is another important factor in flooding potential mapping (Brady and Weil, 2004). Soil permeability and drainage ability are the important soil characteristics that determine the amount of runoff and overland water storage. Therefore, by using these soil characteristics are necessary. However, preparing data compatible to GIS spatial analysis is a delicate task. To make it simpler, a geospatial model was developed in ArcGIS 9.3 ModelBuilder so that with single click of Run button, the required soil characteristics layer would be created. As all the data layers should be in raster format to help in the model development, the soil vector data layer was converted to two different raster using the soil infiltration (hydrologic group) and soil drainage fields, respectively (Figure 05 and 06). While converting the soil feature layer to raster format, it was made sure that the raster cells were 10 meter to be compatible with the DEM. Each raster were reclassified to a rank from 1 to 9 (Table 01) based on the drainability and infiltration rate of the soil texture. Finally, the drainage and hydrologic rasters were combined based on the value (numeric) fields using the weighted overlay tool (Figure 07). Values were scaled from 1 (least potential) to 9 (most potential) to match the evaluation scale of 1 to 9 by 1

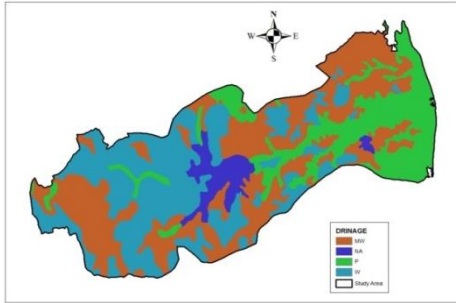


Figure 05: Soil Drainage

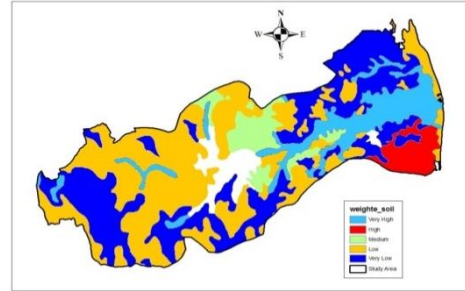


Figure 06: Soil Infiltration

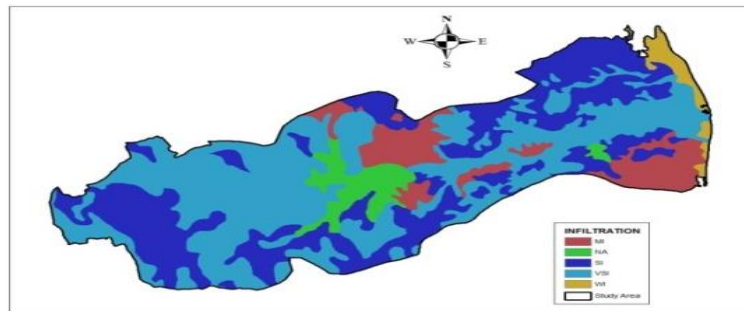


Figure 07: Reclassified Weighted Soil

Table 01: Reclassified Rank Drainage and Infiltration

Classification	Cell Value	Rank (1 to 9)
Drainage		
W(well, low water holding capacity)	1	5
MW (well, intermediate water holding capacity)	2	7
P (poorly, low hydraulic conductivity)	3	9
NoData	4	NoData
Infiltration		
D (very low infiltration rates, clay soils or impervious soils)	1	9
C (Slow infiltration rates)	2	5
B (moderately infiltration rates)	3	7
A (well infiltration rates)	4	1
NoData	5	NoData

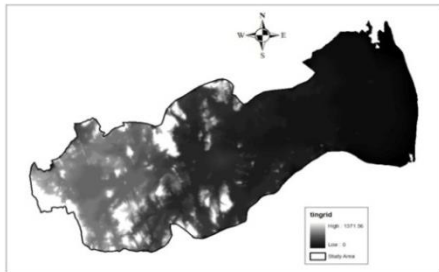


Figure 08: DEM of the Study Area

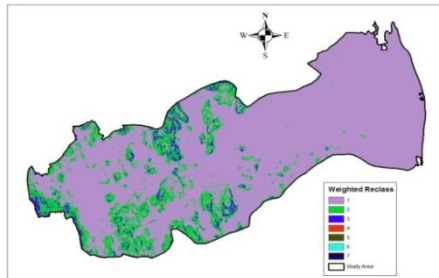


Figure 09: Reclassified Slope

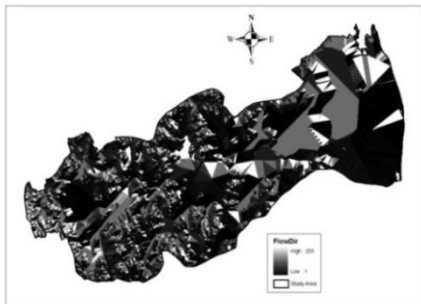


Figure 10: Flow Direction

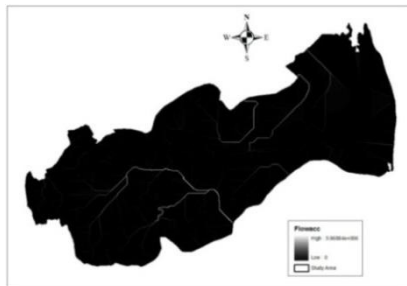


Figure:11 Flow Accumulation

### Weighted Topography Raster Conversion

Slope and flow accumulation are the essential topographic factors that guide the flood potential of spatial areas. Slope and flow accumulation data layers can be generated using the digital elevation model of the study area.

The DEM raster was created to the study area using 3D analysis tool of ArcToolbox. Then the Slope and Flow Direction tools were used to develop slope and flow direction raster, respectively, from the DEM. Flow Accumulation tool was used with the flow direction raster as input to produce the flow accumulation raster (Figure 08 to 11). Each raster (slope and flow accumulation) was assigned Weights at the time of reclassifying, a ranking of least flood potential (1) to most flood potential (9).

When reclassifying continuous rasters (like flow accumulation and slope) the values were grouped into ranges using the equal interval classification scheme with nine classes. For example, the interval of greatest flow accumulation received a rank of 9 and the interval of lowest flow accumulation received a rank of 1. After the reclassification both were overlaid using the weighted overlay tool to get the weighted topography. Slope was weighted slightly more (60%) than flow accumulation because slope has a large influence on flood potential. Figure 12 is the geospatial model developed in ArcGIS 9.3 ModelBuilder to prepare the raster for the flood potential modeling.

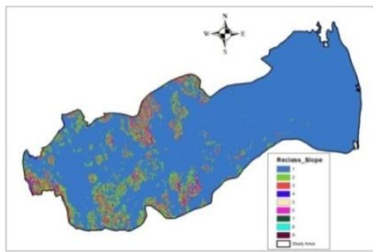


Figure 12: Reclassified Weighted Topography

Table 02: Weighted Vegetation/landuse Class Value

Classification	New Value
Forest	1
Scrub	1
Rubber	1
Homegarden	3
Paddy	9
Grassland	3
Built-up	5

**Weighted Vegetation/Land Use Raster Conversion**

The vegetation is a major restraint for flooding because it reduces the runoff and helps in percolation. Therefore, the land-use raster was reclassified into new values for the old values as given to vegetation class according to the Anderson’s classification (Table 02). Forest classes and they were assigned with the new value of 1. Similarly, national park forest also was assigned with value 1. Similarly the land-use raster was reclassified with scores of 9 (highest for flood potential contribution). Thus, new raster, weighted vegetation/land-use was created. Again, the weighted vegetation/landuse raster was overlayed with the reclassified soil raster to create the weighted vegetation soil raster. Both got 50% of weight

while conducting the overlay. Figure 14 is the geospatial model developed to prepare the weighted vegetation-soil raster.

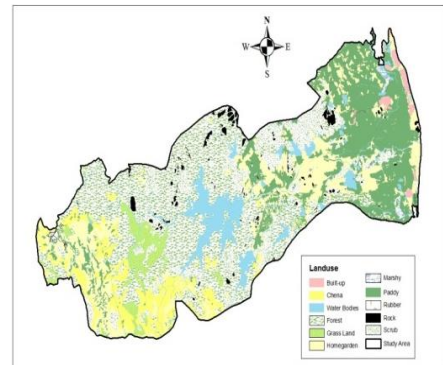
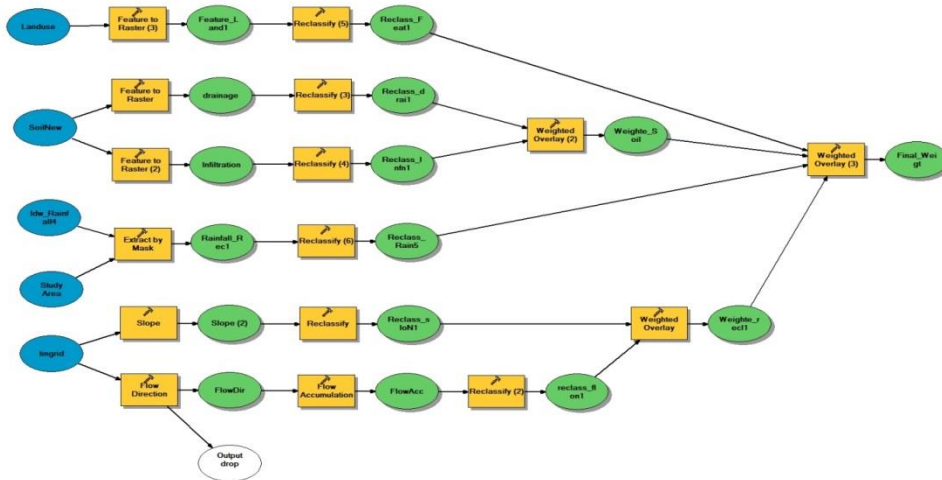


Figure14: Reclassified Weighted Vegetation/Landuse

**Flood Potential Model Development**

Once, all the four raster layers (i) Reclassified precipitation, (ii) Weighted topography, (iii) Weighted vegetation/landuse, and (iv) Reclassified land-use were created using the geospatial models developed, they were weighted overlayed together to produce the final flooding potential map of the Gal Oya River basin. These weighted layers were created in order to reduce the number of inputs in the final weighted overlay. The final output of a flood potential index was a result of equally weighting (25% each) the weighted topography layer, weighted vegetation/landuse layer, and precipitation data. The final comprehensive single geospatial model developed to obtain the flood potential map of the study area is given in Figure15.

Finally, once the flood potential map of the study area is produced, it was classified using the Natural Breaks classification technique into several classes according to the need of the user. In this study we have used five ranks, very low, low, medium, high, and very high potential areas, respectively, to represent the spatial areas of the watershed based on their vulnerability for flooding.



**Figure 15: The Comprehensive Geospatial Model to Develop the Flood Potential Map**

**RESULTS AND DISCUSSIONS**

Figure 16 represent the flooding potential map of the Gal Oya River basin. From the analysis of the result it was observed that most of the Western part of basin is of low flood potential area. The Eastern part of the basin is more flat than the Western portion. It is also closer to the city area and hence devoid of vegetation compared to the western part that is forest cover. There is not much area under the very high flooding potential category as observed from the image visual analysis. Table 03 shows the percentage of area of study area under different flooding potential scale. About 70% of the area is under the low to medium vulnerability with respect to flooding potential. Rest of the 30% area is under high to very high flooding potential area. Flood managers or insurance officers should be interested to develop these areas to decrease the flooding potential in the basin.

appropriate to use sub-annual high intensity precipitation records for accurate flood potential estimation. However, it is to be noted that the use of annual precipitation totals may be too coarse a resolution for accurate flood potential estimation, i.e., precipitation intensity on a given day and given period may vary dramatically at two locations of a basin. Therefore, it would have been more appropriate to use sub-annual high intensity precipitation records for accurate flood forecasting. One more note of this study is that the five gauging station in the basin may be not sufficient to reflect the actual spatial variability of rainfall in the watershed. Therefore, if possible more number of rain gauge stations should be used in analysis. We have developed a procedure for flood mapping in a basin through a developed geospatial model and the model can be modified with precise information as mentioned here.

However, it is to be noted that the use of annual precipitation totals may be too coarse a resolution for accurate flood potential estimation, i.e., precipitation intensity on a given day and given period may vary dramatically at two locations of a basin. Therefore, it would have been more



Table 03: Different Flooding Potential Category

Flood Potential Score	Extent Sq.km	Per cent
Very High	301.71	16.60
High	273.31	15.04
Medium	970.32	53.39
Low	212.79	11.71
Very Low	59.19	3.26

not be as influential under canopy or in grassed areas as it would be for bare ground, fallow pasture, or in urban settings. Therefore, a matrix of coefficients or weights for each raster layer can be used. However, the studied basin does not have that much variability in land-use, so individual weight factors for each raster were rightly used.

**CONCLUSION**

From this study, it was found that geospatial technology has the best potential to undertake complex environmental problems to analyze and provide results required for decision-making. This comprehensive flood potential model developed in ArcGIS ModelBuilder could be easily handled by novice GIS users for decision making. Again, as per advantage of the models developed in ModelBuilder can be easily by replacing inputs to obtained similar maps for other basin or study areas. Therefore, the models developed as part of this study could be easily replicated elsewhere.

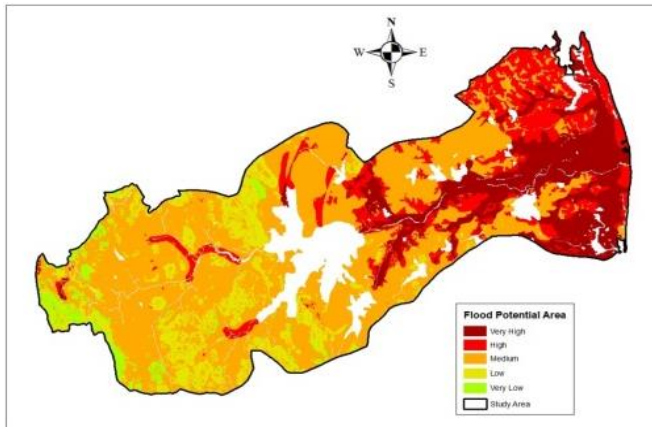


Figure 16: Flooding Potential Map of the Study Area

In case of environmental analysis, weighted overlay with uniform weight allocations to spatial parameters may be not perfect for entire basin spatial locations. For example, slope may

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## **Disarmament, Demobilization and Reintegration (DDR) in Post-Conflict Societies**

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### **Abstract**

The purpose of this study is to understand the concept and explore the reasons why the disarmament, demobilization and reintegration (DDR) of ex-belligerents has characteristically been so essential to achieve peace in societies emerging from years of armed conflict. (DDR) of former combatants have become an integral part of peacekeeping operations and post-conflict reconstruction plans. The success of such programmes is essential for sustainable peace and development. Following the end of the cold war, the international community shifted its attention from dueling ideological warfare to the many intra-state, or internal armed conflicts occurring globally. The United Nations, along with a wide array of aid agencies, have devoted greater and greater time and resources in post-conflict environments. Programmes that address ex-combatants as well as broader post-conflict recovery are essential. (DDR) is one such programme that has received widespread attention. Policy analysts have debated the factors that contribute to a successful DDR programme. In a key component of peace processes and post-conflict reconstruction is the (DDR) of ex-combatants. From the combatants who lay down their weapons, to the governments that seek an end to armed conflict, to the communities that receive—or reject—these demobilized fighters. At each level, these transitions imply a complex equation between the demands of peace and the clamor for justice. Based on that, this research will deliver a critical analysis of the DDR's achievements of this process. It may also allow conclusions on the overall prospects for theoretical approaches to DDR in their practical application.

**Key words:** DDR in post war society, Post-Conflict Development, post-war security sector reform, Role of UN in Peace Building,

*“In the civil conflicts of the post-cold-war era, a process of disarmament, demobilization and reintegration has repeatedly proved to be vital to stabilizing a post-conflict-situation; to reducing the likelihood of renewed violence, either because of relapse into war or outbreaks of banditry; and to facilitating a society's transition from conflict to normalcy and development.”*

Ex- UN Secretary General Kofi Annan

### **Conceptual Analysis of DDR**

In post-war societies, the Demobilization, Disarmament and Reintegration (DDR) of ex-combatants are integral parts of post war development to conflict. Although there is no universal application of a DDR program in all conflict-afflicted countries, it is imperative to understand the basic elements of DDR.

#### **Definition of DDR**

The concept of DDR may vary according to the context in which one operation is implemented as well as actors who implement it. According to the Report of the Secretary-General to the UN Security Council, the activities of disarmament, demobilization and reintegration are defined as follows:

**Disarmament** is the collection of small and light and heavy weapons within a conflict zone. It frequently entails the assembly and cantonment of combatants; it should also comprise the development of arms management programmes, including their safe storage and their final disposition, which may entail their destruction. Demining may also be part of this process.

**Demobilization** refers to the process by which parties to a conflict begin to disband their military structures and combatants begin the transformation into civilian life. It generally entails registration of former combatants; some kind of assistance to enable them to meet their immediate basic needs; discharge, and transportation to their home communities. It may be followed by recruitment into a new unified military force.

**Reintegration** refers to the process which allows ex-combatants and their families to adapt, economically and socially, to productive civilian life. It generally entails the provision of a package of cash or in-kind compensation, training, and job- and income-generating projects. These measures frequently depend for their effectiveness upon other, broader undertakings, such as assistance to returning refugees and internally displaced persons;

economic development at the community and national level; infrastructure rehabilitation; truth and reconciliation efforts; and institutional reform. Enhancement of local capacity is often crucial for the long-term success of reintegration. (UN.DDA:2003)

### **What are the objectives of DDR?**

DDR has the following objectives:

1. To contribute to security and stability by facilitating reintegration and providing the enabling environment for rehabilitation and recovery to begin;
2. To restore trust through confidence-building among conflicting factions and with the general population;
3. To help prevent or mitigate future violent conflict;
4. To contribute to national reconciliation; and
5. To free up human and financial resources, and social capital, for reconstruction and development. DDR alone, however, cannot be expected to prevent further conflict and restore stability. It must be accompanied by other economic, political and social reforms. DDR must therefore be conceptualized, designed, planned and implemented within a wider recovery and development framework.

### **DDR in Post-War Situation**

Effective peace-building in armed conflict is dependent on successful implementation of DDR of former combatants into civilian life. DDR is imperative in promoting political and economic solutions to conflict, because it facilitates the restoration of security on the ground, and creates an impetus for recovery of a country emerging from conflict. DDR makes a crucial contribution to stabilizing a post – conflict situation, reducing the likelihood of renewed violence either because of a relapse into war or outbreaks of banditry and to facilitating a society’s transition from conflict to normalcy and development. (UN doc. :S/2000) Effective DDR ultimately leads to a successful and lasting transition from conflict to peace.

Since the end of the Cold War, dozens of DDR programmes have been carried out, mostly under international leadership, often within the framework of a UN peacekeeping (PKO) or peace support operation (PSO), or at least with considerable financial and logistical participation of various international actors, such as the World Bank, the United Nations Development Programme (UNDP), the International Labour Organization (ILO) and numerous other national development agencies and non-governmental organizations (NGOs) active in the area of development co-operation and peace consolidation.

In post-conflict situations internal and external actors must cooperate in mutually reinforcing the socio-economic, governance, and security dimensions of a highly fragile environment. The result must be an integrated approach to development, the strengthening of structures that allow for the peaceful resolution of disputes, and the prevention of violent conflict.

Since the end of the cold war, the international community has shifted its focus from what for decades was characterized by duelling ideological warfare to the many masked internal armed conflicts taking place throughout the world. In doing so, international organizations and States have placed post-conflict peacekeeping and reconstruction at the top of their humanitarian and development agendas. The development community has recognized that the insecurity that persists in the aftermath of armed conflict can impede development efforts and progress toward meeting the Millennium Development Goals and sustainable peace. There is also evidence that insecurity, intensified by the prevalence of small arms and the ex-combatants that possess them, can have a negative impact on the economic and social conditions of countries emerging from conflict (Muggah 2005). At the end of conflict there is often a surge of ex-combatants entering the highly competitive labour market. Many times ex-combatants lack skills, assets,

and social networks that enable them to create sustainable livelihoods. As a result, ex-combatants may return to war or a life of criminality and banditry that could adversely affect the peace process. Providing support for ex-combatants is therefore central to any post-conflict reconstruction process.

DDR has been increasingly regarded as a priority in post-conflict peace-building efforts during the past and present decade. The first United Nations peacekeeping operation to conduct disarmament and demobilization was the United Nations Observer Group in Central America (ONUCA) in 1989. (UN doc.: S/2000) . Since then, a number of UN operations assumed various responsibilities for DDR, either within or outside of the mandate. (UN doc.: S/2000) The Brahimi Report of the Panel on UN Peace Operations recommends that demobilization and reintegration programs are to be considered for the first phase of complex peace operations in order to facilitate the rapid disassembly of fighting factions and reduce the likelihood of resumed conflict. (HinakoToki: 2004) Therefore, DDR programs are primary elements in all new peacekeeping and peace-building operations. In view of addressing the institutional capacity of the UN system to support DDR efforts, the UN established a Task Force on DDR in September 1999. The Task Force, chaired by the United Nations Development Programme (UNDP), developed guidelines on the institutional division of labor of DDR as well as a broad strategy for DDR. (Hinako Toki:2004) It defined a leadership and coordination framework in the context of DDR, and developed ways of mobilizing the wide range of expertise and resources available both within and outside of the UN system. (Hinako Toki:2004)

In addition to the changes within the UN system, both multilateral and bilateral aid donors have increasingly recognized the significance of support for DDR activities. In recent years the World Bank has become

increasingly involved in providing technical, financial and capacity-building support in the area of DDR. (Sean Bradley.et.al:2003) As a prime example, the World Bank set up the Multi-Donor Trust Fund to facilitate broad donor support to the DDR program in Sierra Leone, which accounted for roughly 50 percent of the overall resources invested in the DDR activities.(World Bank:2003) Other financial support by the World Bank included direct financing through Emergency Recovery Credits, budget support and a Post-Conflict Fund Grant. (Sean Bradley.et.al:2003). In addition, as the Organisation for Economic Co-operation and Development (OECD) guideline of conflict prevention explicates, the Development Assistance Committee (DAC) members have come to agree on the eligibility of a broad range of peace-related assistance to be classified as official development assistance (ODA). These include, for instance, demobilization and explosive mine removal for developmental purposes. (Hinako Toki: 2004). These positive trends in donor attitudes concerning DDR demonstrate the wide acknowledgement of DDR and peace-building as central issues leading to development.

The process of DDR cannot be viewed as a simple sequence of events, but rather, these activities form a continuum and are related and mutually reinforcing.(Hinako Toki:2004). In particular, the reintegration component represents a complex element of the DDR process, which needs to be pursued in a broader national strategic plan for reconciliation, reconstruction and development (Hinako Toki:2004). As Joanna Spear rightly argues, reintegration is the most effective way to break former combatants' ties to their former military units and allows a means for them to provide for their dependents.(Joanna Spear:2002) At the same time, it is imperative to strike a balance between assisting ex-combatants and other sectors of the war-affected population. It is important to avoid giving the misleading impression that ex-combatants are rewarded

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for their acts during the conflict. The ultimate goals of DDR are to reintegrate former combatants in the community where they may reconcile with other people affected by the conflict and to restore the society resilient to conflict.

In response to the challenge of building human security in post-conflict settings, the international community has instituted a programme most commonly referred to as DDR – three distinct yet overlapping components. Under varying nomenclature, DDR programmes are implemented by the United Nations, the World Bank, international and local non-governmental organizations (NGOs) as well as the Organization for Economic Co-operation and Development (OECD) nations. In his report to the United Nations Security Council (UNSC), Kofi Annan reaffirms, ‘the matter of disarmament, demobilization and reintegration of ex-combatants in a peacekeeping environment as part of its continuing effort to contribute to enhancing the effectiveness of United Nations peacekeeping and peace-building activities... has repeatedly proved to be vital to stability in a post-conflict situation; to reducing the likelihood of renewed violence, either because of a relapse into war or outbreaks of banditry; and to facilitating a society’s transition from conflict to normalcy and development’ (UNSC 2000a:1).

Through processes such as the United Nations’ Integrated DDR Standards (IDDRS), the Stockholm Initiative on DDR (SIDDR) and the Multi-donor Reintegration Programme (MDRP), there has been a growing acceptance that DDR, as opposed to simply a military activity, must be treated as a political, social, and economic process that intersects with sustainable long-term development (Bell & Watson 2006). Whereas disarmament and demobilization primarily focus on the individual, reintegration shifts from the individual to the community that the ex-combatant is relocating to. In order for DDR programmes to succeed, sufficient

resources and planning must be invested in the reintegration phase. It has been shown that in cases where donors have reduced or eliminated funding prematurely during reintegration, ex-combatants have been likely to resort back to lives of violence and crime. If left untreated, ex-combatants may form criminal gangs and militia groups, partaking in crime based on trade in drugs, stolen goods, and illicit weapons (Muggah 2005), as was the case in Angola, in the late 1990s, where reports linked high levels of crime and banditry to the failure of the DDR programme (UNIDIR; 1999). While all three elements of the DDR process are equally important in restoring peace and security, this paper will primarily focus on reintegration, the longest and most often neglected phase of DDR. The successful reintegration of ex-combatants presupposes that there is a community that is socially and economically ready and able to receive them.

However, DDR processes have often inadvertently excluded children, and especially girls, as was the case in Angola and Liberia. (Hinako Toki: 2004). By the same token, DDR initiatives, at times, have failed to acknowledge female combatants. For example, the demobilization program in Mozambique only granted resettlement allowances to men and only men's clothing was issued. (Sally Baden:1997) In the course of planning DDR programs, special attention must be paid to the needs and priorities of female and child combatants, as well as other vulnerable groups such as disabled/chronically ill soldiers, and family members of demobilized soldiers. DDR activities that only focus on one segment of society, often former male combatants, without considering how that group interacts with the rest of society, only have limited success in transforming them into civilian life.

### **From DDR to Development**

The economic benefits of ending a war extend well beyond savings in military-related costs. DDR initiatives affect the economy at both VOLUME VIII (1), JUNE 2014 ISSN: 1391-6815

macroeconomic and microeconomic levels. On the one hand, they contribute to the restructuring of government spending; on the other hand, they allow many people to enter the civilian labor market. (Colletta, Kostner and Wiederhoefe :2001) Financial and economic returns resulting from DDR exercises can indicate a “peace dividend” for the government and the economy. But, it is probable that a substantial peace dividend will not be achieved in the short run, especially when the costs of DDR programs are enormous. Precise calculation of a peace dividend also may not be possible due to lack of relevant official data. However, peace dividends of DDR need to be understood in broader social and economic terms as well as in financial terms. (Colletta, Kostner and Wiederhoefe: 2001)

In order to enhance the economic impact of DDR processes, it is suggested to link a country's overall macroeconomic reform program, especially as it concerns the public expenditure mix, to the planned reintegration program. (Colletta, Kostner and Wiederhoefe: 2001) This can be achieved by associating reintegration initiatives with public works programs designed to rehabilitate the basic economic infrastructure, for instance, rebuilding roads, bridges, schools and health clinics. These labor-intensive projects would create a significant number of jobs in the short- to medium-term, at an important period of social adjustment for demobilized soldiers. At the same time, the demobilized would acquire skills and work experience that would help them find work or create employment opportunities in the future. (Susan Willet: 1997)

Incorporating a development perspective in the reintegration of ex-combatants can serve to benefit all members of a community. On the one hand, the reintegration of ex-combatants into civil society can place a heavy burden on a country's labor market. Yet, on the other hand, ex-combatants can contribute to economic development by

entering into productive, income-generating activities.( Colletta, Kostner and Wiederhoeft:2001) Furthermore, the involvement of ex-combatants in measures to rehabilitate the infrastructure is effective in enabling the receiving communities to experience a direct and tangible improvement in the post-conflict situation. This, in turn, would raise the level of social acceptance for ex-combatants by the community members. Therefore, well-designed labor-intensive projects for rehabilitation of community with an appropriate long-term perspective can create a ground for sustainable development.

Another important factor of addressing the post-conflict reality of DDR is the reduction of poverty. As Paris notes, greater levels of economic inequalities result in civil unrest, which increases the likelihood of conflict recurrence. (Paris, Roland :1997). The poor members of the society are more tempted to fall into the traps of fighting groups since this is considered a chance to step out of their current economic situation. The aforementioned strengthening of the systems of public health and education is a move towards reduction of poverty, since it will allow the poorest members of society to get reintegrated in the economic life again. Once dependent on the economic forces, the members of society will have more incentives to preserve the created status quo, because the opportunity cost of returning to conflict would be too high. At the same time, political and economic elites will become more dependent on the work force, which will preclude any one-side exploitation of resources.

### **DDR in Practice**

Post-conflict societies that have been involved in human rights abuses and mass killings are often left with low levels of trust and damaged social capital. As for ex-combatants, the DDR process strips them of their social status, their sense of importance, their income, and their support network (Hazen 2007). This is exacerbated by the reluctance of communities to accept the return of ex-

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combatants, who in many cases had committed atrocities in the very communities that they wish to return to. In Uganda, for example, distrust and resentment were widespread during the initial stages of demobilization and reintegration. Communities were unwilling to accept the return of ex-combatants that had terrorized their lives for so many years. In some cases, this led to hostilities and alienation in the early phase of reintegration (Colletta et al 1996).

In order for ex-combatants to reintegrate, they must relinquish ties with wartime social networks, and reacclimatize themselves with a new social structure, which includes unfamiliar norms, beliefs, and laws within the community. Making this transition can be confusing and psychologically traumatic for ex-combatants and the communities that they return to. Therefore, successful long-term reintegration, as part of the DDR process, can positively impact conflict resolution processes (Colletta, et.al 1996). On the other hand, failure to conduct well planned and funded reintegration programmes can lead to further deterioration in social capital, poor economic conditions, and possibly violence. Reintegration programmes that use existing community organizations enable communities to take ownership of development, while facilitating the reintegration of ex-combatants. Informal networks among ex-combatants, such as discussion groups, veterans' associations, and business ventures are key elements for successful economic and social reintegration. These networks are especially powerful in societies where social capital is scarce (Colletta 1997).

Both ex-combatants and the community can benefit from the many networks of trust that result. It is essential that ex-combatants be fully engaged in the formation of civil society, which is both a by-product and a generator of social capital (Levinger 2005). To achieve this, economic and social reintegration must be embedded in a larger process that



addresses ex-combatants within the development framework of their communities.

Since the early 1990s we have witnessed a significant decline in the number of ongoing armed conflicts and at the same time a dramatic increase in the number of Disarmament, Demobilization and Reintegration (DDR) programs. It is clear that DDR has become part and parcel of peace processes and peacekeeping operations. Research on the subject matter is thriving, and is rich with valuable insights and anecdotes the groups attempt to promote systematic, rigorous and broad comparative studies, including large-scale field surveys, which are of policy relevance. The ultimate goal is to improve and inform policy.

A particularly striking aspect of research on DDR is that, in its narrow focus on implementation issues, it often loses sight of the fundamental research questions that should motivate it. Consequently, existing studies of DDR programs often cannot say much about the effect of these programs on peace building after civil war. The field, at its heart, concerns the stability of peace after civil war, and the links between conflict (or prospective conflict) and economic development. In what follows, we re-focus attention on these issues and on the need to investigate whether DDR programs indeed help to enhance stability and development in a post-conflict environment. Ultimately, this is what practitioners want these programs to do.

The Final Report of the Stockholm Initiative on Disarmament Demobilization Reintegration (SIDDR), under the auspices of the Ministry of Foreign Affairs of Sweden, reflects this understanding: “The SIDDR...defends a conception of DDR which aims to stabilize the post conflict situation, while at the same time keeping the long-term peace-building agenda in mind” (SIDDR 2006:14). (UN IDDRS: 2006)10

In this report, four distinct goals that are commonly attributed to DDR processes:

- Preventing civil war from recurring, mainly through improving economic development;
- Preventing crime and violence;
- Stimulating civic and political participation; and
- Healing trauma caused by the experience of war.

For as long as warfare has existed societies have confronted the problem of what to do with combatants once hostilities cease. Following international wars there is little concern that ex-combatants may threaten the peace, either between the states or domestically, although ex-combatants may pose a problem for public order. But when civil wars end, the presence of armed elements with few alternatives to practicing their violent skill-sets poses a threat to consolidating gains made in peace processes near their conclusion, or to the stability of an already concluded peace. Disarmament, Demobilization, and Reintegration (DDR) programs have developed as a response by the international community to the perceived risk of a return to violence if former combatants are not rehabilitated and reintegrated into society.

DDR programs involving the World Bank, the United Nations (UN), and other international actors date to the late 1980s, and have grown rapidly in number and scope. In all, DDR programs were implemented in a total of 51 civil wars that were active during the period 1979 to 2006. If we consider only civil wars that ended from 1994 on (or were ongoing during that time) and for which the DDR process also occurred, we are left with DDR programs related to 38 post-civil war contexts. This indicates a sharp increase in the incidence of new DDR programs from the mid-1990s on. (Doyle and Sambanis: 2006)

### **War Recurrence and the Conflict-Development Nexus**

The chief concern in a post-conflict environment is preventing the resumption of hostilities. DDR programs are thought to reduce the risk of a war recurring in a variety

of ways, by: Reducing the availability of weapons; Geographically dispersing ex-combatants and disrupting their social networks; Providing ex-combatants with economic opportunities unrelated to conflict; Building confidence between former warring parties, including restructuring the military; and Helping governments realize peace dividends.

At the micro level, the “R” (Reintegration) in DDR programs is thought to influence the overall risk of war recurrence by enhancing the economic opportunities of former combatants. This view is consistent with currently popular economic models of civil war, according to which one would expect the risk of war to be greatest where the economic opportunity costs of war are lower. (Collier and Hoeffler :2004 & Chassang and Padró I Mique :2009)). The “Ds” help in other ways: through “micro-disarmament,” DDR programs can reduce the prevalence of small arms and make a rapid re-mobilization for violence harder. (Pike and Taylor: 2000). Similarly, the risk of recurrence can be reduced through DDR program-achieved demobilization, which severs the ties between former combatants and the command structure. (Humphreys and Weinstein: 2009). At the macro level, one mechanism through which DDR programs are supposed to contribute to peace is through reductions in military expenditure, following the restructuring and downsizing of the military, which should lead to greater economic growth, (Kingma:2002). And consequently reduced risks of civil war down the road. Disarmament also serves a symbolic purpose (signifying the end of war) and tests the parties’ commitment to the peace process, thus building their confidence in it and each other. (Gleichman et. al. 2004:17) and Ball and van de Goor :2006:4)

The broader literature on the recurrence of civil wars supports the plausibility of these conjectures concerning the possible role of DD in peace building. Doyle and Sambanis (2000, VOLUME VIII (1), JUNE 2014 ISSN: 1391-6815

2006) find evidence that multidimensional UN peace operations substantially increase the likelihood that post-conflict peace will be sustained (see also Fortna 2004). Glassmyer and Sambanis (2008) show a correlation between power-sharing agreements and more durable peace settlements (see also Hoddie and Hartzell [2003]). A causal connection is hard to establish, although there are several plausible mechanisms, including the perception that such outcomes are more democratic and the confidence-building effects of power-sharing. Two types of power-sharing are the integration of former warring parties into the institutions of government, and the integration of their forces into the national military, both of which can be facilitated through DDR programs.

### **Conclusions and Recommendations**

Along with the increase of involvement of the international community in post-conflict assistance, has come a greater focus on DDR. It has been well established that DDR is an essential component of post-conflict recovery. While development and humanitarian organizations focus on improving political and economic institutions and upholding the peace, particular attention must be paid to ex-combatants, who are most prone to become spoilers of the peace process. Given their access to weaponry, their experience with armed violence, and left-over animosity, ex-combatants are most likely to return to violence if conditions do not allow them to make the transition from war to peace. In post-conflict settings, economies and institutions are too damaged and fragile to absorb tens to hundreds of thousands of ex-combatants at once. Therefore, it is imperative that well-planned and dynamically funded DDR programmes are implemented.

While disarmament and demobilization are important, it is the reintegration phase that requires the greatest amounts of time and funding for successfully assisting ex-combatants and their return to sustainable livelihoods in their former or sometimes new

communities. Typically, reintegration targets the individual ex-combatant with cash packages and job training. More recently, there has been a shift in conventional wisdom, calling for a community-focused approach to reintegration. Consequently, this study argues that both individual and community-based reintegration approaches are important when conducting DDR programmes.

Disarmament, Demobilization and Reintegration continues to play an important role in peace and state building initiatives as it contributes to a secure environment required for long term development. It should also be borne in mind that DDR is directly linked to opportunities for reforming the overall security sector in post-conflict situations and therefore, policy makers should take into account this interdependence. Synergies between DDR especially reintegration efforts, and development programs by the Bank and its partners in RMCs should be harnessed. These synergies are necessary for the sustainability of donor interventions and for the transition from fragility post-conflict phase to long-term development.

DDR programs should be designed and implemented in a way that avoids creating new social status. The use of labels such as “ex-combatants” or “the demobilized” has normative, economic and bureaucratic implications associated with it. These names/labels may be necessary at the beginning to help identify target groups and beneficiaries of DDR, but they must eventually disappear, and these individuals must become permanently integrated into society.

There is need to enhance the absorptive capacity of host communities. The programs should be specific and associated with identifiable community needs. This calls for a needs assessment of communities. DDR programs should be designed based on the aspirations of both the community and ex-combatants.

Major post-war DDR took place in a wide range of countries in the 1990s and 2000s. In all most all cases, DDR played significant role in the rehabilitation, peace building and development processes. Some experiences in DDR have been very positive. Ex-combatants return to peaceful work and received considerable support from their families and communities. However, some others have failed or have not significantly contributed to peace building and human development.

Lastly, this paper presents a range of issues that will require special attention in responding to new efforts to support DDR and in anticipating demobilization in the future. For example, more attention should be paid to the broader economic, institutional and security environment. Various groups of ex-combatants have special needs, which play role in the type of assistance required. In addition, psychosocial and human rights aspects also deserve to play an important role in the design and implementation DDR support. A debate on these issues would help to refocus and strengthen the potential for effective and efficient external support for peace building and human development.

At present, there is hope for Liberia, Sierra Leone, Burundi and Aceh with respect to "bridg(ing) the transition for humanitarian relief to a country's return to a conventional development trajectory". We do not know yet where these countries will be in five or 10 years time, but what we certainly do know, is that a successful DDR process, a successful transformation of units of combatants to civilian movements, is the precondition for a return to development policy normality. This holds true for the past and is the prospect for the future. Failed demobilisation efforts have repeatedly led to a flaring-up of the war: in Angola (1994 and 1997), in Liberia (1996) and in Sierra Leone (latest 1999). For Haiti, Colombia and the DR Congo, the disarmament of certain groups (paramilitaries in Colombia, Rwandan "génocidaires" in the

Congo, armed gangs in Port-au-Prince) is seen as the key to bringing movement to the bogged-down peace processes<sup>208</sup>.

When DDR programmes focus on combatants and the stability of post-conflict situations with their operational targets, they create the environment in which long-term post-conflict peace building can commence. Therefore, one can argue that DDR is a window of opportunity for post-conflict peace building as well as for development cooperation in the post-conflict societies.

Further research is needed on country specific experiences in post-conflict reconstruction and reintegration. In addition to this, the motivations and underlying causes of conflict (human rights abuses, weak electoral systems, high corruption and government ineffectiveness, break-down of rule of law and ethnic tensions among others) in post-conflict countries need to be addressed otherwise the probability to return to violence for the same reasons is high.

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