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No. 2008-002

Impact of 2004/2005 Drought on Zambia's Agricultural Production: Preliminary Results

By

Thamana Lekprichakul
Research Institute for Humanity and Nature

March 2008

Vulnerability and Resilience of Social-Ecological Systems

RIHN Research Project 1-3FR

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Thamana Lekprichakul
Research Institute for Humanity and Nature
Kyoto, Japan
E-mail: Thamana@chikyu.ac.jp

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Abstract

This paper examined the extents of Zambia's crop losses resulting from the 2004/2005 agricultural droughts and how the impacts were distributed among different cropping systems. The drought analysis is based on the Post Harvest Survey of 2003/2004 and 2004/2005 agricultural seasons, conducted annually by the Central Statistical Office (CSO). The results indicated that the 2004/2005 agricultural drought may have been more serious than initially thought. The extents of crop damages were comparable to the severest drought in recent history in 1991/1992 agricultural season. This was due largely to a rapid expansion of cultivated areas in the 2004/2005 of approximately 50% over the 2003/2004 season. The yield losses of staple crops were similar in their extent around 40%, 50% and 60% for millet, maize and sorghum respectively. It was observed that drought-resistant crops like millet and sorghum suffered greater crop losses than did the maize, particularly in southern province. This peculiar characteristic may have been a result of non-climatic factors that exacerbate the damages to the crops. Farmers responded with various coping strategies ranging from engaging in petty trades, skipping meals, eating wild foods, migration, to desperate measures such as stealing and prostitution.

Key words: **Drought impact analysis, Agricultural drought, Food security, Yield losses**.

要約

本稿では、2004/2005 年農作期旱魃から、ザンビアの農業収量の損害を調査し、損害がどの様に異なる生産システムに分布していたかを検討する。旱魃の分析はザンビア中央統計局(CSO)が毎年実施している 2003/2004 年と 2004/2005 年の農作期の収穫後調査に基づいている。分析の結果から、2004/2005 年の農作期旱魃は当初推計されたものより深刻であった可能性がある。穀物の損害は近年最大の旱魃であった 1991/1992 年農作期に匹敵するものであった。これは、主に 2003/2004 年に比較して 50%増加した 2004/2005 年の急速な耕作面積の拡大によるものであった。主食穀物の収量損害はミレットで 40% 、メイズで 50%、ソルガムで 60%にものぼった。旱魃に耐性のあると考えられているミレットとソルガムはメイズより特に南部州で損失が大きかった。この不可解な現象は損害を拡大した気候以外の要因によるものかもしれない。農民は小規模な売買への従事、食事の回数減少、野生植物の摂取、移住から、窃盗、売春までさまざまな対処戦略によって旱魃に対応していた。

キーワード：**旱魃影響分析、農業的旱魃、食料安全保障、収穫被害**

Introduction

Drought is a major threat to Zambia's food security. Although Zambia is land abundance relative to her population, a significant part of arable land is in a semi-arid region that is frequently hit by drought. Only three percent of the country's arable land is under irrigation. The remainder depends critically on rain fed subsistence agriculture. Such rain fed agriculture coupled with thin public resource endowments put Zambia in a precarious position to deal with drought impacts. Poverty, though improving over time, remains widespread. On average, every seven out of tenth Zambians are living below poverty line (CSO, 2005). In rural area where the majority of small holders are located, poverty is even more pronounced. Eight in ten rural residents are poor. As a heavily indebted country with public debt of 32% of GDP, capability of Zambian government to absorb drought impacts is limited.

This paper examines impacts of recent drought in 2004/2005 agricultural season on production, market and country's food security. Data analysis is based on reported production of the Post Harvest Survey of 2003/2004 and 2004/2005 agricultural seasons. The survey is conducted annually by the Central Statistical Office (CSO). Chief purpose of this examination is to assess degree of seriousness of the 2004/2005 drought episode, and what impact it had on maize market, price and income. In addition, the paper seeks to how drought impacts distribute across cropping systems.

The paper progresses in the following order. The next section will give an overview of current economic situation and agricultural sector's roles on Zambian economy. It will then follow by looking at agricultural drought in the past 16 years since 1989/1990 to 2004/2005 planting seasons. Past drought episodes will be compared and contrasted with the most recent one by focusing on their impacts on crop failures. The third section will shift attention to drought situation at provincial level by focusing on what happened in our study areas in southern and eastern provinces. The fourth section will compare and contrast agricultural production in southern and eastern provinces versus that of the rest of the country. The fifth section review farmers' coping behaviors. The paper concludes by identifying some key research questions for theme IV in understanding household, community and regional response to climatic variability.

An Economic Overview

Zambia is a landlocked country locating in the southern part of the African continent and is bordered by the Republic of Congo and Tanzania in the north, Malawi and Mozambique in the east, Zimbabwe and Botswana in the south and Angola in the west. The country is rich with natural resources such as land, copper, zinc, coal, cobalt and many others. Together, mining, agriculture, fisheries and forestry accounts for approximately one quarter of the Zambia's GDP in 2005 (see Figure 1). The growth of this primary sector in the recent decade (see Figure 2 for economic trend) has been driven by the forestry sub-sector due to rising demand and prices of timber and timber products. It is worth noting that the share of mining sector (as represented by the white area in Figure 2) has substantially shrink from what it was a decade ago in 1994. The manufacturing sector which comprises of manufacturing, electricity, and construction shares another quarter of GDP. The marked growth of the manufacturing sector in recent years since 2000 was spurred by the construction sector which reflects optimism in economic outlook of Zambia. The largest sector is services which account slightly over half of GDP. The prime contributor to the growth of service sector was wholesale and retail trade which is the largest sub-sector in Zambia.

Zambia is relying on natural resources as an earning source of foreign currency. Copper, mineral, precious metal and stones accounted for nearly 70% of Zambia's export. Cotton and sugar and confectionary products contribute another 10% to export. The remaining 20% are miscellaneous. South Africa is the biggest trading partner of Zambia following by the United Kingdom. However, the Switzerland is the biggest exporting market of Zambia. Approximately a quarter of Zambian export went to the Switzerland. Trade with Japan is small. Only two percent of imports were from Japan (CSO, 2006). Overall, Zambia continues to experience trade deficit. However, Zambia had small balance of payment surplus as a result of positive net capital inflow.

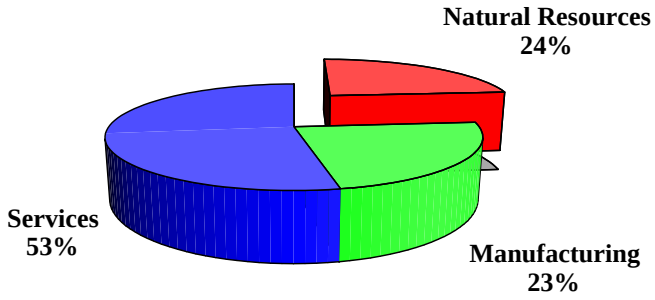

Figure 1: **Share of Production Sector as Percentage of GDP**

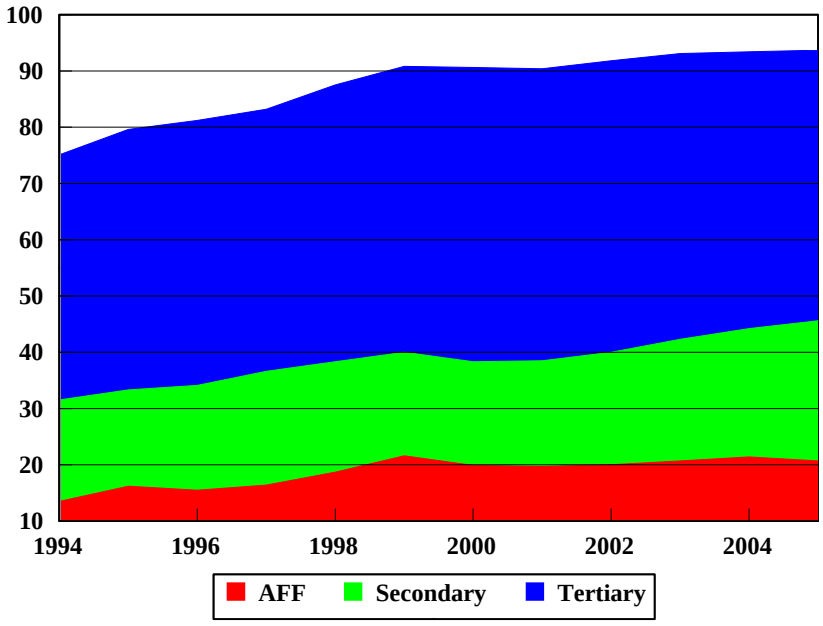

Figure 2: **Percentage Share of GDP by Economic Sectors**

The Agricultural Sector

Zambian agriculture has two important characteristics. First, agricultural system has dualistic sub-sectors, a mixture of small land holders and large to very large scale corporate farmers. While 85 percent of farming households holding less than 5 hectares of land and use simple and somewhat primitive production technology, about 10 percent of large scale farmers cultivate 20-150 hectares of land and use mechanized farming techniques. A dozen of large corporate farms on more than 1,000 hectares of land using highly mechanized production technique with hired labors and advanced irrigation system to grow maize and cash crops. Maize productivity of the large scale and corporate farms is several times higher than that of the small sized farmers. Yields of large farms are around 5-6 metric tons per hectares (MT/Ha) while the national average yield during good harvest year during 1990-

2005 periods is 1.84 metric tons/hectare. Secondly, irrigation system is limited and irrigable crop land is largely occupied by large scale farmers and corporate farms. The vast majority of farmers are heavily dependent on rain-fed farming. Their livelihoods are especially vulnerable to drought which unfortunately has become more frequent occurrence during the past two decades.

Agricultural sector is often recognized as a key contributor to Zambia economy and is estimated to contribute about one-fifth to GDP. However, a careful examination of Zambia's national production reveals that the significance of agricultural sector to Zambia may have been overstated. In nominal term, agriculture, forestry, and fisheries (AFF) contributed 20.7 percent to GDP in 2005. In real term, the share of AFF is historically around 14 percent (see Figure 3). In 2005, AFF's contributions to real GDP of 14.2 percent were only second to the wholesale and retail trade sector at 18.3 percent (CSO, 2006). Among the real sector, however, AFF is by far the biggest. Such dominant role of agricultural sector disappears when one stop equating agriculture to the combinations of agriculture, forestry and fishing. By considering each component of AFF separately, contribution of agriculture to nominal GDP is no more important than is the communication and transport sector to Zambia. Among the real sector, agriculture contributes only four percent to GDP and ranks forth following forestry, construction, and food, beverage and tobacco (see Figure 4). Since relative importance of GDP components is sensitive to relative price changes, it is instructive to consider agriculture importance by fixing relative price to a based year. Figure 5 and 6 clearly show that the importance of forestry is exaggerated because of favorable price increases. Its share fell from 15 to merely 5 percent. On the other hand, the significance of agriculture and fishing is understated because of their depressing prices. The agriculture sector contributed 6.5 instead of 4.4 percent to real GDP. Over time, however, the falling real share of agriculture clearly suggests that the sector is falling behind the growth of other sectors.

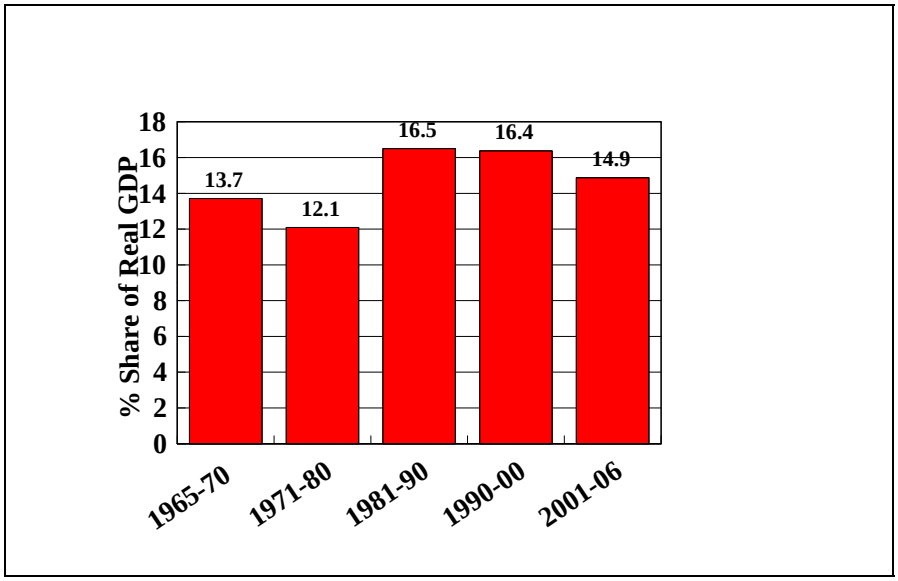

Figure 3: **Agriculture, Forestry and Fisheries As Percentage Share of Real GDP**

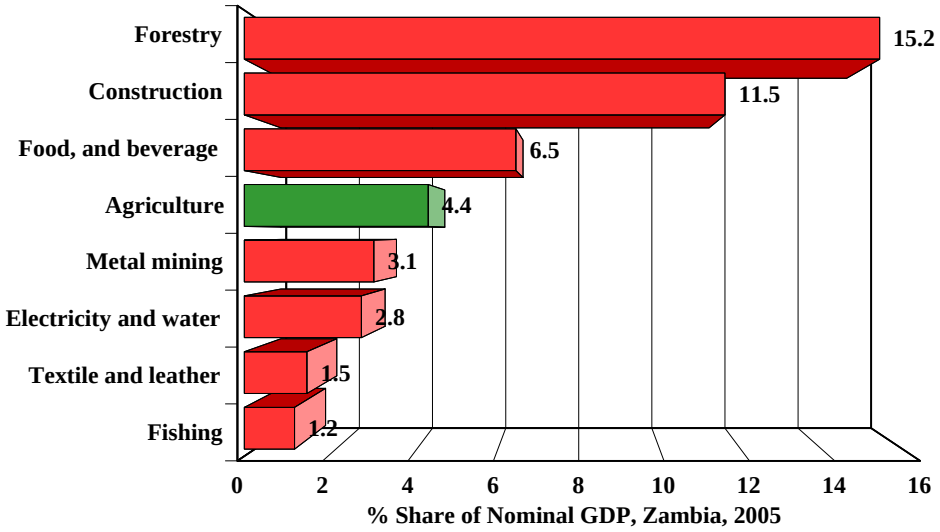

Figure 4: **Percentage Share of Nominal GDP by Sector, 2005**

It is incomplete to weight significance of the agricultural sector without considering employment absorption. Although the agriculture industry reportedly employ merely 15 percent of labor force in the formal sector (CSO, 2005), the 2000 census found that 70 percent of usually working population were in the agriculture sector (CSO, 2004). Similarly, the World Food Program estimated that livelihoods of three-quarters of Zambian population are directly or indirectly dependent on agriculture (FAO/WFP, 2006). The CIA World Factbook ranks Zambia as the six highest nations to have labor force in agricultural sector at

85% (CIA, 2008). When employment share is considered, agricultural sector is unequivocally Zambia's most important economic sector.

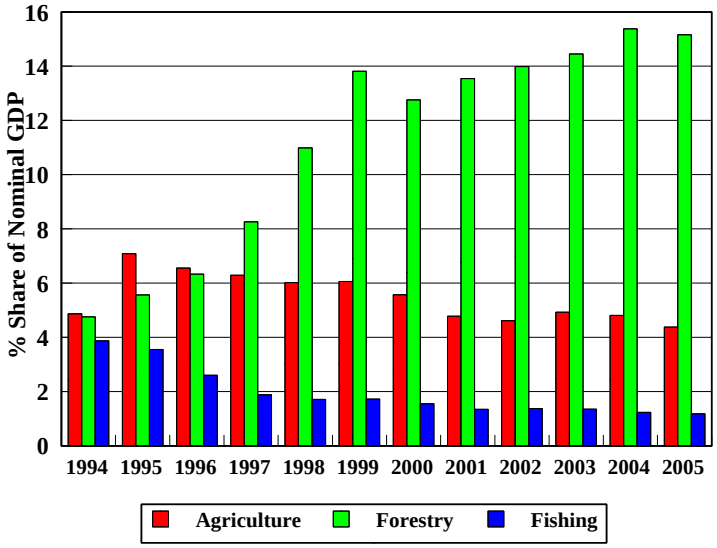

Figure 5: **Percentage Share of Nominal GDP, 1994-2005**

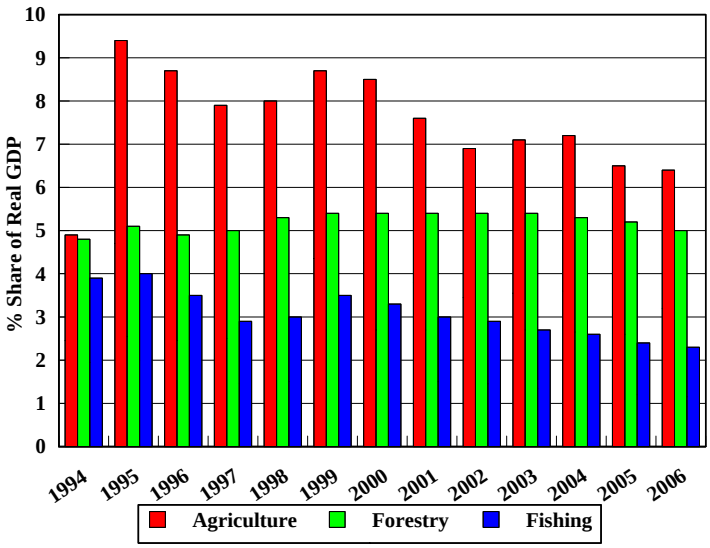

Figure 6: **Percentage Share of Real GDP at Constant 1994 Price, 1994-2006**

To examine drought impact on income, national income account is crude but sensible place to start. Surprisingly, agricultural sector in 2005 registered a healthy growth of 13 percent in GDP at current price despite the drought. However, the real production of agriculture, forestry and fisheries sector in 1994 constant price declined by 0.6 percent, a significant U-turn from the previous year in 2004 when AFF achieved a strong positive real growth of 4.3 percent. The decrease was attributable to lower output by 4.0 percent in the

agriculture sub-sector. The negative growth of agriculture was offset, in large part, by positive gain in forestry and, in small part, by fisheries. The poor harvest was a result of drought in 2004/2005 agricultural season (CSO, 2006). The difference between the nominal and real growth rate is due to difference in relative prices. From the implicit GDP deflator, it is estimated that the 2004/2005 drought episode caused the price of agricultural sector to rise by 18%.

That drought caused significant damages to major crops such as maize, millet and sorghum. According to the Post Harvest Survey conducted by CSO, production of staple crops which include maize, millet, sorghum and rice dropped by 22 percent from 1,134,319 tons in 2003/2004 to 884,575 tons in 2004/2005 planting season[1]. The decline was due mainly to drought effects on production of maize which is the main staple food and accounted for more than 90 percent of cereal production. Maize registered a drastic decrease of 233,234 tons or about 22 percent from a year before. The widespread production of maize even in the areas that are not appropriate for maize production was historically encouraged by past governments through price distortion program (Chizuni, 1994).

The negative four percent growth rate of the agricultural sector in the GDP is estimated to be an income loss of at least 8.6 billion kwacha at 1994 constant price. At current price, the damage is estimated to be around 59 billion kwacha which is about US$14.8 million at an exchange rate of 4,000 kwacha/dollar. The values of the production loss are about one–sixth of national cotton export in the same year. There are two important assumptions underlying this estimate, i.e. cultivated area in 2004/2005 season is identical to that in 2003/2004 and amount of rain fall is similar to the previous season. The assumption on equal area under crop is, in fact, invalid because planted area significantly increase over the seasons in question. If the production loss is compared to a good rain fall year, the estimated loss would be much higher. Therefore, the actual loss estimate is likely to be higher.

Drought Situation

In the past 16 years from 1990 to 2005, Zambia experienced six droughts in 1991/1992, 1994/1995, 1997/1998, 2000/2001, 2001/2002 and 2004/2005 (see *Figure 7*). On

[1] CSO published different agricultural production estimates for 2004/2005 planting season. The estimates are currently, at best, preliminary. The actual productions reported here are based on data from actual Post Harvest Survey. The magnitude of the changes in planted area and productions are *unusually* large. Verification of the validity of estimates is on going.

average, droughts occur once every 2-3 years. There are some similarities and differences between the drought episode in 1991/1992 and that in 2004/2005. While the 1991/1992 drought is continental, the 2004/2005 drought is local. The 1991/1992 drought episode completely affected the entire country of Zambia as well as other countries in the southern Africa. Besides being a local drought, the 2004/2005 episode is partial. Many provinces were affected but the Northern, part of Northwestern, Luapula and Copperbelt provinces were spared.

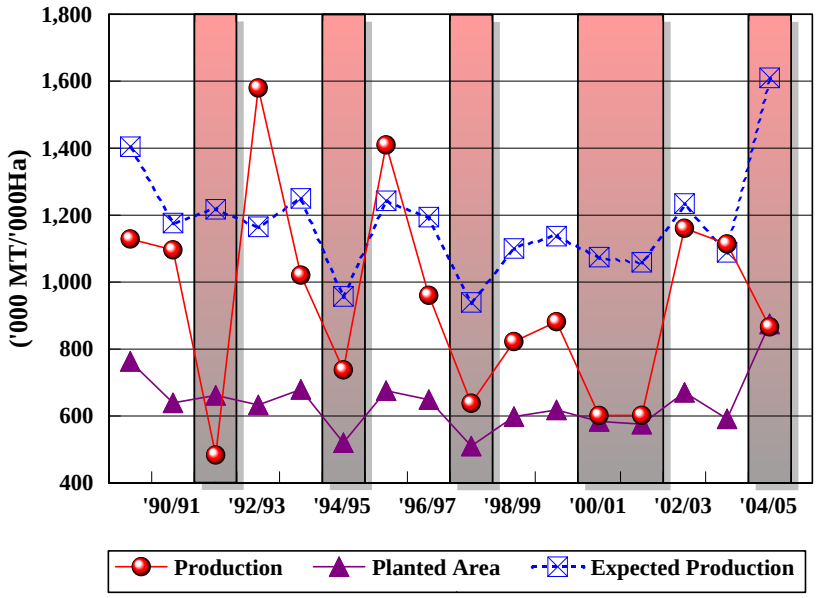

Figure 7: Maize Production, Expected Production and Planted Area, Zambia

Note: Highlights indicate drought year and distance between actual and expected production measures crop losses.

Although the scope of those two drought episodes is different, the scale of production losses is similar. Maize production failures in 2005 were estimated at 740,000 metric tons (MT), the biggest production losses in recent history. Maize failures in the 1992 drought stood at 730,000 MT, only about 10,000 MT less crop losses than that in 2005. As far as assessment of severity of drought is concerned, magnitude of crop loss alone can be misleading indicator especially when planted area significantly differs. Such is the case for the two drought episodes. In 1992, farmers planted maize on 660,000 hectares of land, whereas 875,000 hectares of maize crop was grown in 2005, a 30 percent more maize land exposed to climate variability over the 1992.

In term of year-to-year change, maize land planted increased considerably by 285,000 hectare from 590, 000 hectares in 2003/2004 to 875,000 hectares in 2004/2005, an increase of

48 percent! There is no evidence of shifts in crop patterns. In fact, there appeared to be rapid increase in cultivated land for a majority of other crops as well. The overall increase of cultivated area in 2004/2005 was 46% over the 2003/2004 agricultural season. How and why such dramatic increase of planted land for maize and other crops occurred within such a short period of time are issues still under careful investigation.

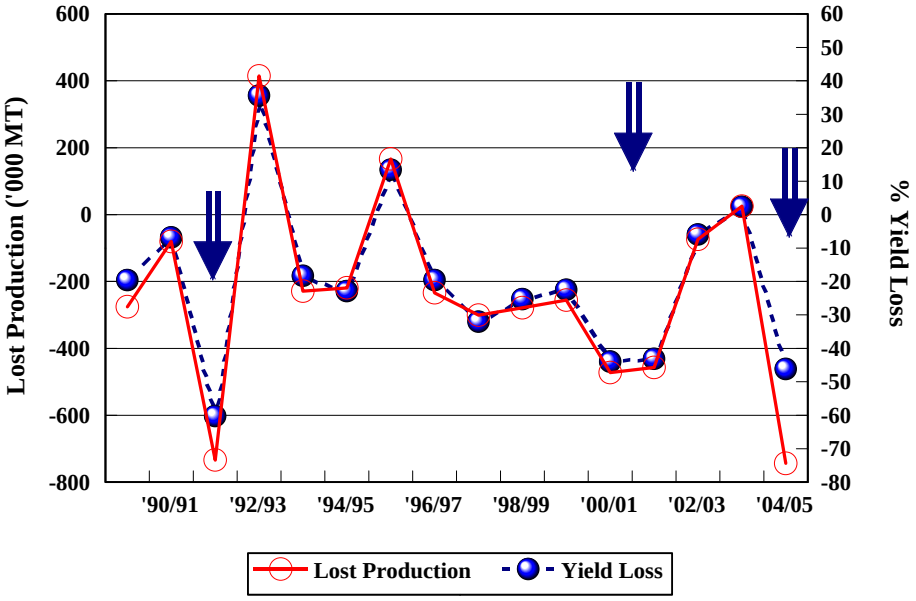

Figure 8: Maize Production Losses and Yield Losses, 1989/1990-2004/2005

Yield losses are better comparative measures of drought impact because the planted lands are normalized to one. When yield loss is considered, however, the 1992 episode remains the most severe drought in the past 16 years of Zambia agricultural history. In 1992, the yield loss was 60 percent vis-à-vis 46 percent in 2005. The rate of land productivity loss of the 2005 drought was comparable in magnitude to those in 2001 and 2002 with yield losses of 43 and 44 percent for 2001 and 2002 respectively (see *Figure 8*). Arrows in *Figure 8* point to the years in which severe droughts occurred.

In addition to examining the *rate* of crop losses, it is also crucial to investigate drought impact on *level* of remaining food supply or food security. The 1991/1992 episode of drought left the country with dangerously low maize supply. Production level of the 1991/1992 was about 40 percent of average production in good harvest years during the past 16 years. The maize production harvested in 2004/2005 was about 73 percent of the same good-years average. The food need gaps were filled by imported maize. In 1991/1992, Zambia imported maize for nearly 1 million tones whereas 270,000 tons of maize were

imported in 2004/2005. In response to the moderate shortfall of domestic maize supply, maize price increased by nearly 60 percent from $150/MT in 2003/2004 to $236/MT in 2004/2005. The increase was the second largest in the past decade following the 66% price rise in the 2000/2001 drought episode. Figure 10 shows inversed relationship between drought impact and maize prices. Roughly, a 10 percent increase (decrease) in maize yield will result in approximately 7 percent decrease (increase) in maize price.

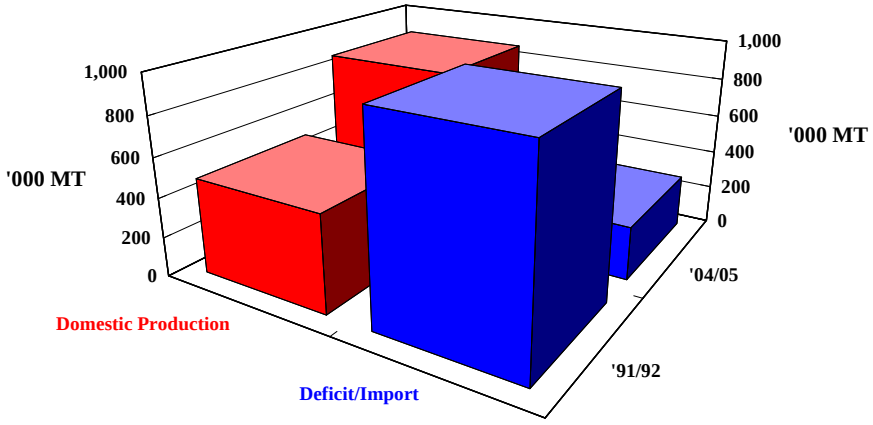

Figure 9: Maize Supply by Sources between 1991/1992 and 2004/2005 Droughts

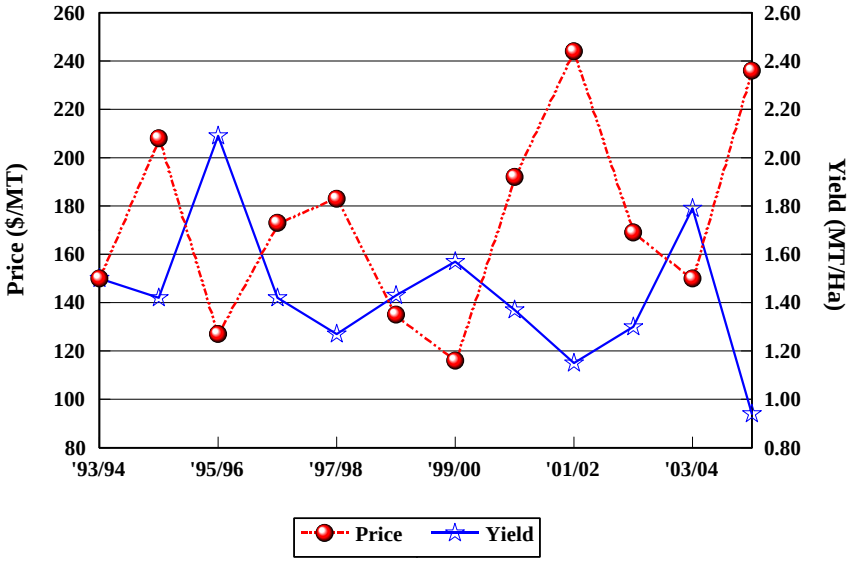

Figure 10: Drought Impact on Maize Price (Mill Price in Lusaka)
Source: Haggblade, (2006), for maize price data.

Table 1 shows production of cereal crops other than maize for each province. At first glance, it may seem that the drought of 2004/2005 had little impact on production of rice, sorghum and millets which are known to be more tolerant to dried weather condition than is

maize. Production of rice and millets fell by only 2 and 4 percent respectively. Sorghum production, however, suffered a huge drop of nearly 50 percent from a year before. When small drops in production of drought resistant crops were accompanied by a large increase in planted land ranging from 28-55 percent (see *Table 2*), yield losses became substantial. Rice, a relatively insignificant cereal crop in Zambia, experienced the smallest productivity loss of 28 percent. Yield loss of millet is slightly below that of maize at nearly 40 percent; sorghum was the cereal crop most affected by drought at 60 percent. The higher yield losses among drought resistant crops were unexpected and counter intuitive. More research is needed to understand reasons underlying this unexpected phenomenon. Overall, the Zambia Vulnerability Assessment Committee estimated that 1.2 million people, approximately 10 percent of Zambia population, required food or cash assistance during the hunger period in January to March 2006.

Table 1: Production of Maize, Millets, Sorghum and Rice at Provincial Level, 2003-2005 (`000 MT)

Province	Maize		Millets		Sorghum		Rice	
	2004/05	2003/04	2004/05	2003/04	2004/05	2003/04	2004/05	2003/04
Central	122.1	207.1	1.2	1.8	1.4	3.4	0.0	0.2
Copperbelt	71.2	84.4	0.6	0.1	1.2	2.8	0.0	0.1
Eastern	196.6	296.7	0.7	0.7	1.1	1.8	3.7	5.2
Luapula	31.3	18.9	1.5	1.8	0.8	0.9	1.0	0.7
Lusaka	22.2	33.2	0.0	0.0	0.1	0.2	0.0	0.0
Northern	98.7	76.8	21.5	18.5	1.8	1.6	10.1	5.7
Northwestern	63.9	41.2	0.6	0.3	1.7	4.3	0.5	0.1
Southern	171.1	239.9	1.5	4.0	2.5	7.6	0.0	
Western	44.2	56.3	3.8	5.6	4.3	6.9	1.7	5.3
Zambia	**821.2**	**1,054.4**	**31.4**	**32.9**	**14.9**	**29.6**	**17.1**	**17.4**

Source: PHS 2003/2004 and 2004/2005

Table 2: Chang and Percentage Change of Planted Area, Production and Yield of Cereal Crop

Crop	Area Planted ('000 Ha)		Production ('000 MT)		Yield (MT/Ha)	
	Change	%	Change	%	Change	%
Maize	284.4	48.15	-233.2	-22.12	-0.85	-47.43
Millet	28.2	55.25	-1.5	-4.46	-0.25	-38.46
Sorghum	12.5	27.64	-14.7	-49.74	-0.40	-60.62
Rice	5.6	37.32	-0.3	-1.75	-0.33	-28.45

Source: PHS 2003/2004 and 2004/2005

Drought in the Southern and Eastern Provinces

The 2004/2005 season's rainfall in the southern provinces was characterized by late planting rains, below average quantities, and poor and erratic rainfall distribution. As for the eastern province, rainfall pattern was slightly different. Heavy rain came at the start of

planting season and then followed by prolong dried spells in the latter part. Despite early heavy rainfall, the amount of precipitation was below average level. As a result, water table was at usually low level. Many wells and some boreholes dried up threatening the survival of farmers and livestock.

Agricultural Production in Eastern and Southern Provinces

The southern and eastern provinces are key players in Zambia's agricultural sector. About 40-50 percent of planted land and 35-45 percent of all agricultural production are from these two provinces despite being drought prone areas. More importantly, the southern and eastern provinces are Zambia's main suppliers of maize and other cereal crops. In 2003/2004 season, the pair contributed 50 percent of maize and cereal productions. Last year, in relation to the rest of the country, the two were disproportionately affected by below normal level of rainfall and, yet, they still maintained 40 percent contributions to the national cereal production.

Table 3: Agricultural Production and Planted Area, Southern and Eastern Provinces vs. Other Provinces, 2003/2004-2004/2005

Crops	Planted Area		Production		Yield	
	S & E Provinces	Other Provinces	S & E Provinces	Other Provinces	S & E Provinces	Other Provinces
2003/04						
Cereal	328,467	373,375	555,842	578,477	1.69	1.55
Other crops	218,991	453,399	163,643	686,046	0.75	1.51
2004/05						
Cereal	447,683	584,832	377,137	507,438	0.84	0.87
Other crops	327,126	280,941	167,903	186,005	0.51	0.66

Source: CSO, Post Harvest Survey 2003/2004 and 2004/2005.

Agricultural production in the dyad provinces has two distinct characteristics. Firstly, flexibility of shifting crop pattern differs between the two regions. During the two periods under study, the crop pattern in the two provinces was stable over time. Farmers in the provincial pair allocated planted area in a 3:2 ratio between cereal and other crops, i.e. 60 percent of land for cereal production and 40 percent for production of cash and root crops. Crop distribution pattern in other provinces was more dynamic. In 2003/2004, farmers in provinces other than the southern and eastern allocated approximately equal ratio to cereal and other crops. In the next season, they oriented their production toward cereal crops with 70 percent cereal and 30 percent cash and other crops.

Why did farmers in the two regions behave the way they did? There may be many probable explanations. One of those may lie in the two regions' comparative advantages. While the southern and eastern provinces are significantly more productive in producing cereal (yield of 1.69 vs. 0.75 tons/hectare for cereal and other crops respectively), the rest of the country were equally productive in producing either (see *Table 3*). During good rainfall years, it is, therefore, reasonable for those other provinces to allocate roughly equal share of land to either crop. However, in drought year, the farmers in other provinces would be better off growing more cereal than growing other crops because those non-cereal crops were more susceptible to drought. Based on this limited evidence, farmers in other region could have suffered more cop losses if they did not shift their crop combinations. There is not enough information to determine how decision about crop combination was made and whether climatic expectations play any role in that decision. What we observed could have happened by chance. However, if it was not, this limited evidence might have suggested that Zambian farmers were rational and quite good at adjusting their crops to expected environmental risks, given their limited resources.

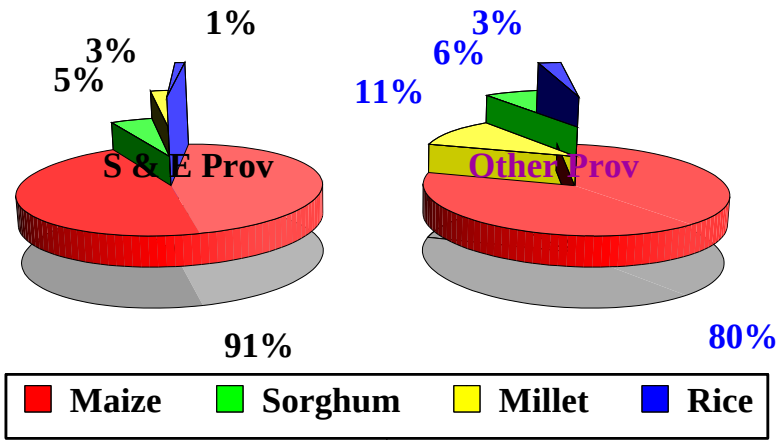

Figure 11: Distribution of Planted Land for Production of Cereal Crops, Southern-Eastern Provinces versus the Rest of the Country, 2004/2005

Secondly, degree of diversification differs between the two regions. About 90 percent of cereal land in the southern and eastern provinces was devoted to maize production and the remaining 10 percent for millet, sorghum and rice. Maize remained the most popular cereal crop in other provinces but farmers in those provinces allocated only 80 percent to maize and the remainders for dried weather tolerant crops (see *Figure 11*). It is interesting to note that other provinces appeared to have slight comparative advantage over the two provinces in

growing millet and sorghum. What roles productivity plays in crop diversifications are not immediately clear. Conventional wisdom has it that farmers' different attitudes toward risks are considered an important factor explaining different diversifying behaviors. It would be a challenge to quantify degree of risk aversion among different groups of farmers from the existing datasets.

The percentage yield losses of sorghum and millets were significantly higher than maize during drought in the southern and eastern region. While yield losses of sorghum and millet were at 70 percent, productivity losses of maize was at only 50 percent (see *Figure 12*). This peculiar phenomenon runs counter intuitive and appears to come mainly from the southern province (see subsequent section). In other provinces, yield losses of millet and rice were at 33 and 25 percent respectively, whereas failure rate of maize was at 45 percent which is comparable to that of sorghum. It is worth noting that the odd pattern of production failure among dried weather tolerant crops like millet and sorghum and water-hungry crop like maize does not exist in this region. More field research is needed to uncover possible explanations for this unusual occurrence.

Table 4: Production of Cereal Crops in Southern and Eastern Provinces vs. Others

Crops	Planted Area		Production		Yield	
	S & E Provinces	Other Provinces	S & E Provinces	Other Provinces	S & E Provinces	Other Provinces
2003/04						
Maize	300	291	537	518	1.79	1.78
Sorghum	16	29	9	20	0.58	0.69
Rice	4	10	5	12	1.16	1.17
Millet	8	43	5	28	0.57	0.66
2004/05						
Maize	409	466	368	454	0.90	0.97
Sorghum	21	37	4	11	0.18	0.30
Rice	5	15	4	13	0.70	0.88
Millet	13	66	2	29	0.17	0.44

Source: CSO, PHS 2003/2004 and 2004/2005.

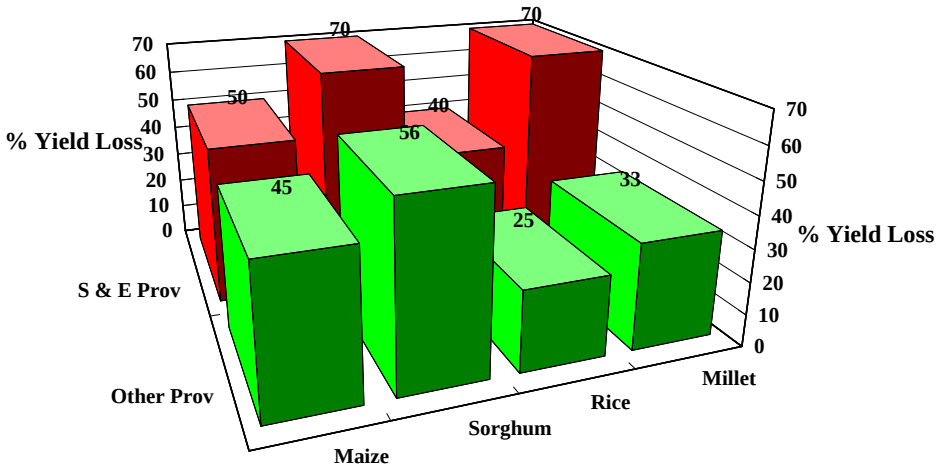

Figure 12: Percentage Yield Losses of Cereal Crops, Southern and Eastern vs. Other Provinces, 2004/2005

Crop Production in Southern vs. Eastern Province

Crop patterns in 2004/2005 planting season in the southern and eastern province are slightly different. While farmers in the southern allocated about 70 percent of their crop land to cereal production and the remaining for cash and other crops, those in the eastern province equally distributed their land between cereal and other crops. As a result, this more diversified composition of crop portfolio enabled eastern province to be at a relatively better position to deal with agricultural and environmental risks (see *Figure 11*). However, from year to year change, crop portfolio composition of southern province appears to be changing. Cereal crop share dropped from 80 percent in 2003/2004 to 70 percent in 2004/2005 (see *Figure 12*). If his trend continues, more cash and other crops will be grown in the southern province and, hence, a more diversified crop portfolio.

Maize is the most important crops in the two provinces. Despite playing relatively less important role in the eastern province's crop portfolio, more maize was grown in the eastern than in the southern. About 60 percent of combined maize production in southern and eastern province was grown in the eastern, and the remaining 40 percent was from the southern province. However, the southern province was more productive than the eastern in the production of maize to a large extent, i.e. yield of 2.03 vs. 1.63 MT/Ha for southern vs. eastern province respectively. For other crops, there appeared to be no significant productivity differentials between the two provinces. Rice production in the southern province is an exemption. An increase in rice production was due to favorable rice price (FAO/WFP, 2006). Although rice productivity of southern farm was significantly higher

than the eastern, the southerners' rice production remained too small to be meaningfully compared with the easterners'. It is interesting to note that proportionately more of dried weather tolerant crops such as millet and sorghum were grown in southern than in the eastern province.

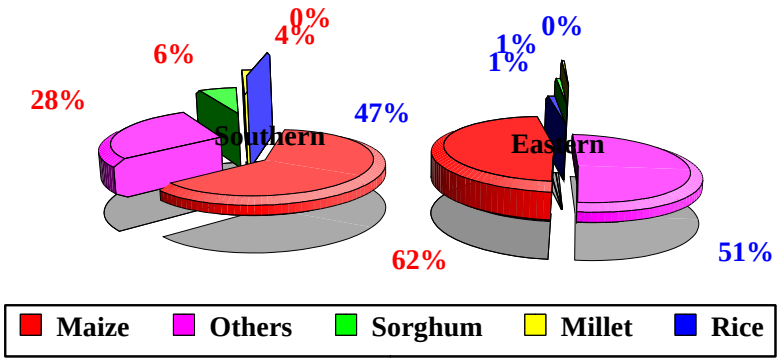

Figure 13: Distribution of Planted Area by Crops, Southern vs. Eastern Province, 2004/2005

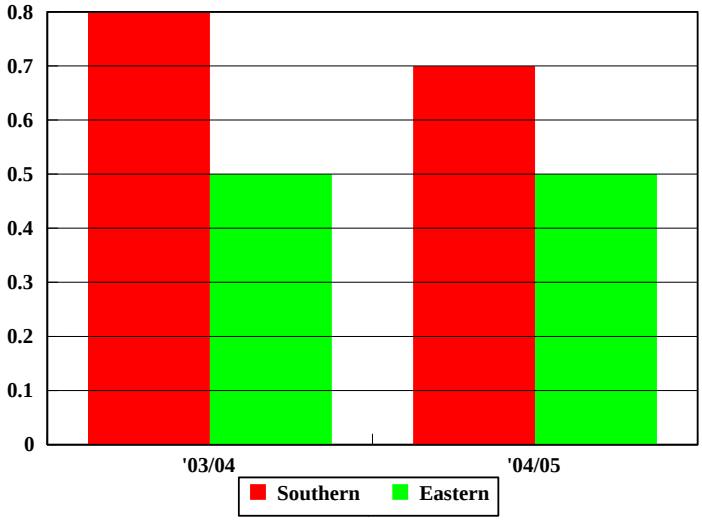

Figure 14: Share of Cereal Crop Land in Southern and Eastern Province

The southern province appeared to sustain marginally greater crop failures than did the eastern during the 2004/2005 drought. The yield losses of cereal and maize production were 54 and 47 percent for southern and eastern province respectively. However, the southern suffered much greater yield losses of millets and sorghum at 75 vs. 40 percent in the southern and eastern province respectively. A question remains as to what factors that might possibly explain the yield-loss rate differentials in the drought resistant crops between those two provinces.

Table 5: Area, Production and Yield by Crops, Southern vs. Eastern Province, 2003/04-2004/05

Crops	Planted Area ('000 Ha)		Production ('000 MT)		Yield (MT/Ha)		Yield Loss (%)	
	Southern	Eastern	Southern	Eastern	Southern	Eastern	Southern	Eastern
2003/04								
Maize	118.0	181.5	239.9	296.7	2.03	1.63		
Sorghum	13.1	3.1	7.6	1.8	0.58	0.59		
Rice	0.0	4.5	0.0	5.2		1.16		
Millet	6.9	1.5	4.0	0.7	0.58	0.50		
Cereal	137.9	190.6	251.5	304.4	1.82	1.60		
Others	43.5	175.5	26.8	136.8	0.62	0.78		
2004/05								
Maize	182.5	226.3	171.1	196.6	0.94	0.87	-0.54	-0.47
Sorghum	17.4	3.2	2.5	1.1	0.15	0.34	-0.75	-0.43
Rice	0.0	5.3	0.0	3.7	2.43	0.69		-0.40
Millet	11.1	1.8	1.5	0.7	0.14	0.36	-0.76	-0.28
Cereal	211.0	236.7	175.2	202.0	0.83	0.85	-0.54	-0.47
Others	82.8	244.3	35.9	132.0	0.43	0.54	-0.30	-0.31

Source: CSO, PHS 2003/2004 and 2004/2005.

Household Response to Drought in Southern and Eastern Provinces

While average crop failure for the region for cereal production was about 50 percent, many households experienced 100 percent crop losses. An early copying behavior of farmers in eastern and southern provinces was engagement in petty trade. Farmers in southern province reportedly engaged in petty trade more intensely than those in the eastern (FAO/WFP, 2006). Consumption of perceived inferior crop like cassava was common in the southern province. When household food supply dwindled, farmers attempted to extend their food stock by skipping meals from three to one or two a day. As household food stock ran out, people in many parts of both provinces were reportedly surviving by eating green mangos, and toxic root. Farmers who live near a forest made frequent visit to the forest to look for wild foods and, in the process, competed with wild animals for dwindling food sources. School children reportedly went to school in the morning without having breakfast and brought home their left over rations. Some distressed farmers resorted to desperate coping behavior such as stealing and prostitutions.

Further Research Questions

As a part of the theme IV of the Resilience Project, our focus is to assess household and community resilience to climatic shock. There are two key research questions: actual drought impacts on agricultural production and market and measurement of household resilience. These two issues are closely related. Resilience of a household can be indirectly

assessed from household coping capability. The stronger the ability to cope, the more resilience is the household. The household adaptability to systemic risks is, in turn, a function of available assets, and the size of the shock. Our study of household resilience can be metaphorically compared to study of car safety through car crash test. The car safety features that protect drivers and passengers are to resilience and the speed of car crash is to the magnitude of climatic shocks. The United States, as one of the most affluent country in the world, was powerless to deal with climatic shock as big as the hurricane Katrina.

The assessment of drought damages in this report is based on simple *unconditional* estimates. Such estimates overstate the actual drought impact because other factors that potentially affect production and correlate with drought are not controlled. There are several economic approaches to obtain *conditional* estimates of drought impact. Given the nature of data available in the Post Harvest Survey, the list includes production function when there is single output, profit function for multiple outputs production function and distance function method.

To measure household resilience, one must first give resilience an operational definition. An opposite of resilience is vulnerability. They are not dichotomous but rather a continuum of the same substance (see *Figure 15*). Resilience can then be defined by degree of vulnerability. Economists view consumption as key element determining well being of an individual. When consumption of an individual falls short of a minimum requirement level, that individual is considered vulnerable. Many studies operationally define vulnerability based on consumption shortfall.

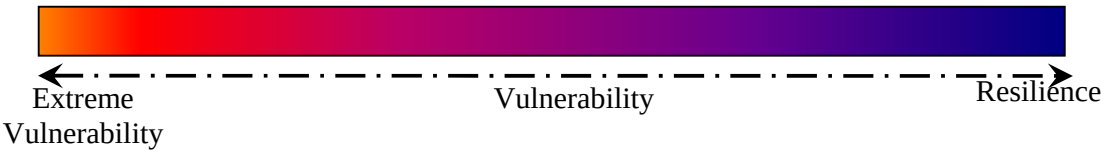

Figure 15: Conceptual Framework of Resilience as a Continuum of Degree of Vulnerability

There are two main methods of measuring resilience. The first is an *ad hoc* index method. This method is based on no economic theory and simply identifies factors affecting or correlating with vulnerability to generate a vulnerability index. Patnaik and Narayanan's (2005) study is one such example. The second method is based on welfare or consumption theory. This camp defines vulnerability as expected consumption shortfall. The work of this approach is still evolving. Some examples of this consumption approach to vulnerability are

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Research Institute for Humanity and Nature (RIHN)
Inter-University Research Institute Corporation, National Institute for the Humanities
457-4 Kamigamo Motoyama, Kita-ku, Kyoto, 603-8047, Japan
www.chikyu.ac.jp

大学共同利用機関法人 人間文化研究機構
総合地球環境学研究所
〒603-8047 京都市北区上賀茂本山 457-4
www.chikyu.ac.jp