

Vulnerability Profiling

One of the key elements of social protection, and in particular when planning programmes and interventions for social protection, is to understand and define vulnerability. This is framed around five key questions: Who is vulnerable? To what are they vulnerable? Why are they vulnerable? What can be done to reduce their vulnerability? What is the likely impact of an intervention on their vulnerability?

Vulnerability Profiling: challenges

The concept of 'vulnerable groups' has been applied recently to both relief and development programmes as an approach to try and ensure that those who are most at risk can be enabled to get necessary assistance. This approach is typically based around fairly fixed categories of 'vulnerable groups' such as women headed households, persons with disabilities and older persons. Sometimes, socio-economic criteria such as land tenure or income are used to classify people. On the basis of classification as 'vulnerable' or 'not', a person or household may be entitled to some form of assistance. This approach assumes that all people with certain demographic criteria (PwDs or older persons) are vulnerable, and would thus need assistance. Whilst it may be true that certain groups of people such as PwDs or older persons are more likely to be vulnerable to certain hazards than others, they may not all be vulnerable, and probably are not vulnerable in the same ways, or for the same reasons. Frequently, this current practice of assigning people to 'vulnerable groups'-typically determined by demographics such as gender, age and disability, by assuming that members of these groups are homogenous and thus equally vulnerable, fails to adequately differentiate between persons with disabilities, or older people, or female headed households, who are vulnerable and those who are not, and moreover, by failing to make detailed analysis of the causes and contributors to vulnerability at household level are not able to design the most effective interventions. Inevitably, being classified as 'vulnerable' is also a relative term, referring not to an absolute, fixed state, but one which is judged in comparison with others, usually locally, and which is also subject to change. This further highlights the need for an approach to measuring vulnerability which is not based on fixed demographic characteristics (otherwise, all PwDs and all older people will always be vulnerable, no matter what).

Key concepts for vulnerability profiling

Firstly, vulnerability needs to be considered in relative terms, and in relation to a certain set of probable threats. For example, we can ask 'Which people are more vulnerable to the impact of a natural disaster?' This question also covers two elements: likelihood of exposure (primary) and likelihood of loss/injury is exposed (secondary). There can be a third element, which is the likelihood of serious longer-term consequences as a result of loss/injury (tertiary) and this is related to resilience. Considering the likelihood of exposure, one needs to establish the list of likely threats and determine which people are more likely to face those threats within a given time period. So, for example, flooding or drought exposure will be determined by macro factors (which region you live in) and more local factors (whether you live near a river). The likelihood of damage/loss is linked to exposure (because some people may be exposed for longer periods or to more extreme conditions than others) but is also linked to more local factors such as house design, types of livelihood, health status, ability to escape to safer places. The likelihood of longer-term

consequences is more directly linked to resilience: the ability to withstand, to respond to, and to build back after exposure to a particular threat. Thus, it is clear that people who live in flood-prone areas are more likely than those who do not, to experience flooding; moreover, those who live in poorly built houses near the river bank are more likely to experience loss and damage than those in better houses. Finally, those who have a few coping mechanisms are more likely to suffer long-term consequences of flood damage than those who have multiple coping mechanisms. Hence, assessing and measuring vulnerability is complex, and is defined by the threat being considered. Having said that, it is still possible to make some generalizations about vulnerability and who might be more vulnerable, particularly when considering resilience. Within the mandate of social protection, protection from exposure to, damage by and consequences of different man-made and natural hazards are included. However, the focus of much of the research which will be presented here is primarily around the third aspect, which looks at resilience and the ability to withstand the damage of a hazard and 'bounce back' to continue to survive or even thrive. Whilst other aspects are important, it is this aspect which is most relevant to much of the work around social security, social welfare and community based social protection schemes.

Having established some understanding of vulnerability, and of the challenges of how to measure vulnerability in a way which is consistent with a rights-based approach and which is not based on fixed demographic characteristics, we can now describe an approach to measuring vulnerability which has the potential to measure aspects of household vulnerability in a more detailed way, potentially allowing us to understand more about why THIS household is more vulnerable than THAT household to a certain type of hazard. Understanding this type of vulnerability profile allows us to then look at what needs to be done to reduce the vulnerability of a certain household, rather than simply classifying the household as vulnerable or not. The model studied in this paper, the 'Umbrella' model, can enable a 'rights based' approach, facilitating inclusion of persons with disabilities (and other 'vulnerable' group members) as active participants in process, but without guaranteeing their status as an automatic beneficiary.

Are vulnerability and poverty the same?

Finally, a common question: what is the correlation between vulnerability and poverty? Are they essentially the same? What is the advantage of measuring vulnerability? Poverty is acknowledged to be multi-faceted, often defying simple analysis and interventions. Whilst measurements exist to quantify poverty in absolute economic terms (for example, \$1 per day purchasing power parity), a more useful poverty measurement needs to reflect the dynamic aspect of poverty. One approach is to measure both chronic and transitory povertyⁱ, and to quantify the extent to which poverty is caused by fluctuations in welfare (transitory poverty) as well as low levels of welfare in the long-term (chronic poverty)ⁱⁱ. Studies of transitory and chronic poverty assert that 'potentially much larger reductions in aggregate income poverty might be achieved by enhancing households' ability to smooth incomes across time'.ⁱⁱⁱ A significant underlying contributors to and causes of transitory and chronic poverty is exposure to, and consequences of, natural disasters and other crises and hazards^{iv}. This in turn also includes analysis of factors which can affect resilience at community and household level. Hence, poverty reduction strategies have included aspects of vulnerability reduction as essential elements. Tools such as the Livelihood Vulnerability Index have been used to measure projected impact (i.e. vulnerability) at community level of the effects of climate change^v. In general, poverty is linked to vulnerability to natural disaster, economic shock and other hazards in a cyclical fashion: poorer households are typically more vulnerable to both exposure to and negative impact from shocks, and the increased exposure and impact contributes to chronic poverty. Hence, any understanding of poverty must also include an understanding of vulnerability. Thus it may be that some households can be considered 'poor' but not necessarily vulnerable, and likewise, some vulnerable households may not necessarily be poor. The overall advantage of

measuring vulnerability is that it can help identify not only households that are already poor, but those that are at risk of becoming poor. This identification of ‘near-poor’ households with vulnerabilities to specific hazards can be of great benefit to poverty reduction programmes. One critical question concerning measurement is, to what extent there is overlap between households classified as poor and households classified as vulnerable? This will be explored further as we consider a specific tool to measure vulnerability.

Umbrella Model to measure household livelihood vulnerability

The umbrella model for measuring household livelihood vulnerability was developed in 2010 by the Livelihood and Food Security Trust Fund, in an attempt to introduce more rigorous and measureable selection criteria to ensure that the right interventions reached those who really needed them. The model is so called because of its application to plot household vulnerability in a user-friendly umbrella style radar plot to illustrate the relative degree of ‘protection’ which a household has against shocks and hazards. The tool draws on Moser’s ‘Asset vulnerability framework’ to measure household economic vulnerability according to ten factors (indebtedness, productive income, livelihood diversity, dependency ratio, asset profile, water & sanitation, food security, health, social capital and decision making power), and was developed according to a livelihood and vulnerability framework developed by the Livelihood and Food Security Trust Fund (Myanmar)^{vi}. The full list of factors and linked indicators is included as Table 1.

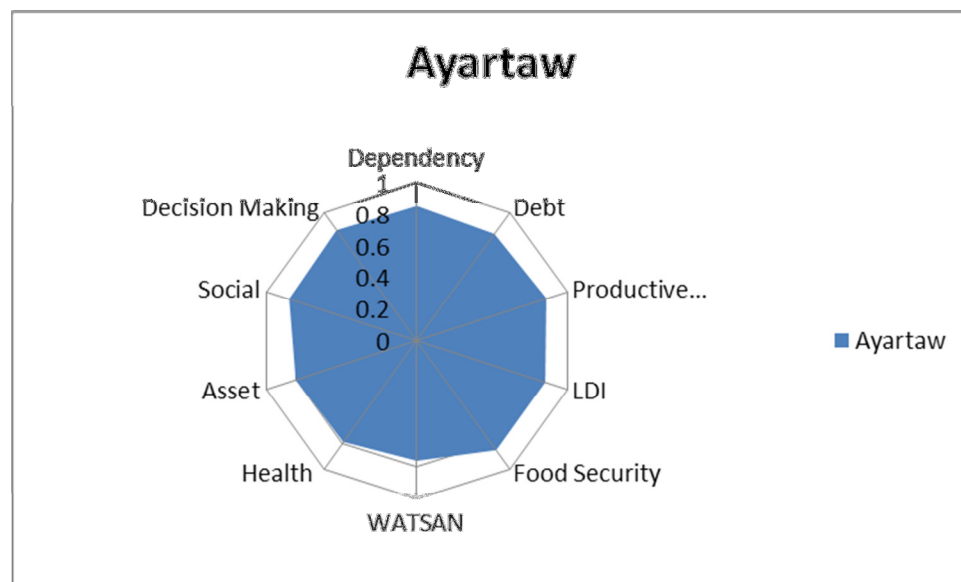
Table 1: Vulnerability factors, contributions to vulnerability, indicators and sources

Factor	Contribution to vulnerability	Indicator	Source & validation
Indebtedness	High levels of non-productive debt put livelihood assets at risk (collateral); repayments may reduce essential expenditure; high levels of existing debt can reduce ability to access additional credit	Debt repayment as proportion of income Repayment: income ratio >30% is usually risky	World Bank 1997 ^{vii} , adapted
Income	Low or negative income: expenditure ratio can lead to reduction in essential spending, increase risk of debt or negative coping responses. High proportion of income spent on non-productive items can lead to under-investment in livelihood, leading to higher risk	Proportion of income expended on non-productive items (food, health, rent, fines)	World Bank 1997, adapted
Assets	Ownership of livelihood assets, convertible assets or crucially, land (in the form of usage right) can provide short term protection against shocks.	Moser’s asset vulnerability Framework, adapted for survey by Myanmar Market Research Department	Moser (1998) ^{viii}
Food Security	Current and prior experience of food insecurity is strongly linked with increased vulnerability to future food insecurity. Likewise, food insecurity leading to malnutrition can affect human capital, and put livelihoods at risk.	Food Security Index	UNDP ^{ix} , modified
Livelihood diversification capacity	Income derived from a single source is more vulnerable to shocks. Multiple sources, or the potential to diversify, can increase protection against shocks affected main/key livelihoods	Livelihood diversity index (= number of income generating activities at HH)	DHS (2006) modified
Health	Chronic or frequent illness in primary earner OR one requiring care threatens livelihood security and reduces income, as well as increasing health expenditure; unplanned health expenditure is a common cause of negative coping (e.g. conversion of livelihood assets to cash)	Income generating household member days per year lost work through illness	UNDP modified

Water & Sanitation	Water is an essential for health and many livelihoods; more time taken to draw water reduces time for other activities; unsafe water sources increase risk of ill health which reduce livelihood effectiveness; unreliable water supplies increase resource expenditure	Average time to collect water	DHS (2006) ^x
Dependents	Household members requiring high levels of social or medical care divert human, physical and financial resources away from potentially productive livelihood activities	Household Dependency scale	TLMI ^{xi} adapted
Social Participation	Persons with higher levels of social participation build up social capital, which can increase the likelihood of relief and assistance in times of difficulty	Participation index	TLMI, adapted from p-scale (KIT)
Decision making	Persons with more influence in decision making can have stronger negotiating position for livelihood related factors such as fair pricing, land and asset use	Proximity to power scale	Adapted UNDP

Factors were measured using standardized indicators, which were then converted by mathematical formulas to a scale from 0-1 to allow input into the vulnerability model. The indicators can be collected at household level, or at community level. Provided that there is a consistent method to convert to a scale, different and even multiple indicators can be used to measure the different factors. This is essential as different indicators, or different calibrations, may be required for different populations or geographical areas. Scores are plotted on a 10-point radar plot, either as a single household plot, a village aggregate, a township or even State level aggregate. A sample model for a household 'plot' is displayed as Figure 1. Higher scores indicate more 'protection' and hence less vulnerability.

Figure 1: sample 'Umbrella' vulnerability profile for Ayartaw Township



This model looks primarily at **relative** resilience, as the capacity to cope with shocks and hazards, rather than relative exposure. Hence, it is best applied to determine which households are more vulnerable within a given population, rather than for absolute comparison between regions or countries. Vulnerability was defined in relative terms, by measuring the relative deviation of a particular household score from the overall population mean. So, the score for each factor is measured against the overall population score. If the household score for that factor (for example, health) was more than one standard deviation below the overall population average, then that factor was classified as 'vulnerable'. Overall, a household was classified as 'Vulnerable' if they had three or more of the ten factors which scored over 1 standard deviation lower than the population mean for those factors.

There are several significant features of this model which need further explanation before we can consider the application of the model. Firstly, the model classifies vulnerability at household, rather than individual level, thus moving beyond fixed demographic characteristics to more dynamic socio-economic characteristics. However, this may mean that some individual vulnerabilities may be masked (such as the vulnerability of older persons within a household). However, in measuring the resilience of a given household, we make the assumption that resources are distributed according to need within a household, thus imputing the overall household vulnerability onto its members.

Secondly, as mentioned above, the model relies on measurement against the population average to determine vulnerability. As there is no national standard, or gold standard, each household's vulnerability is measured against the standard of its local peers. Hence, if a household is classified as vulnerable, it has at least three factors which score significantly lower than the overall population average. In essence, a household is judged according to its neighbours.

Following this, the use of a statistical approach to measure vulnerability (one standard deviation below the average) does mean that vulnerability is dependent on how equally scores are distributed. If some scores were very widely distributed, this would lead to a wider range and a larger standard deviation, meaning that only those with very low scores would be classified as vulnerable. Likewise, if scores are bunched close together, with very little difference between households, then very small differences could lead to being classified as vulnerable. One solution could be to take the average of the scores for all the factors and use that as the basis for classifying vulnerability. However, this would require that each indicators have the same sensitivity and range, in order to contribute equally to the overall score. As this is very difficult to do, the 'three and above' rule (three or more factors more than one standard deviation below the mean) was used. This allows for some errors in households where there may be one or two scores which are low, but the household itself is reasonably secure. However, as with any approach, there are strengths and weaknesses.

The model has been tested in various contexts to assess the suitability in determining vulnerability, and in assisting beneficiary selection. Generally speaking, the model offers a superior approach than more crude tools like wealth ranking, as it can identify households who are not 'poorest of the poor' but who nonetheless are at risk of becoming so. Field testing has demonstrated high levels of satisfaction amongst users and households. Validation is challenging, as there is no comparable 'gold standard'. However, the tool has been used as a baseline for several development projects, and final end-project assessment is expected to demonstrate whether the model was useful in enabling accurate profiling and targeting of vulnerable households.

How accurate and reliable is the Umbrella Model, and how does it compare with other approaches to profiling?

The model has been applied in several different projects, and data has been gathered on over 6,000 households in 7 States and Regions of Myanmar, including specific data on over 1,000 households with persons with disabilities. Analysis of combined data from 5,000 households from a general population demonstrated that overall, 22.65% of all households were classified as vulnerable, when compared with the population sample of 5,000 households. Using a standard measure of poverty (wealth ranking in the lowest quintile) 22.3% of households would be classified as poor, and of these, 49% were also considered vulnerable. This means that of all the people identified as vulnerable, around half will be classified as poor by using wealth ranking, and half will not. Likewise, of all households identified as poor by using wealth ranking, around half would be considered vulnerable, and half would not. This demonstrates that using the umbrella model, a significant proportion of the poor households were captured, but in addition, a significant number of non-poor households were also identified, and a proportion of poor households (as classified using conventional methods) were not classified as vulnerable. Why the difference? Firstly, we need to remember that wealth ranking is established by using the quintile (those in the lowest 5th, or 20%) whereas the Umbrella model used a cutoff of one standard deviation below the population mean. In fact, applying the quintile cutoff to the umbrella model does not significantly alter either the overall proportion classified as vulnerable, or the correlation between those classified as poor by wealth ranking and those classified as vulnerable by the umbrella model. Secondly, we need to remember that wealth ranking is using one factor in an essentially linear approach (any value below a certain point is considered 'poor') whereas the umbrella model, whilst using a linear model for each calculating the vulnerability status of each factor, converts these into a non-linear result by combining the number of vulnerable factors and determining a cutoff point (more than two) as the definition. Thirdly, and most significantly, it should be pointed out that wealth ranking to measure poverty and the umbrella model to measure vulnerability are measuring different things. One is measuring actual wealth, whereas the other is measuring a series of characteristics which may put a household at risk. Hence, although it may be useful to evaluate the ability of the umbrella model to identify poor households, this is not what the model was designed to do. Testing of the model against a wider, community based set of criteria for beneficiary selection of 'poor' households has demonstrated wide variation; however, when applied in conjunction with other tools, the umbrella model has been demonstrated to be a significant asset in terms of assisting accurate mapping of household and community vulnerabilities and priorities. This illustrates the difference between poverty and vulnerability, and suggests that the best application of the umbrella model is on conjunction with other tools. In medical terms, we can think of the umbrella model as a kind of diagnostic test like an X-ray, used to confirm, expand on and potentially identify new issues, but to be used in conjunction with basic diagnostic tools such as a patient history and physical examination.

Another way of evaluating the model is looking at sensitivity and specificity. Sensitivity is the ability of a test to include all 'positives' and to have a low proportion of true 'positives' which are not identified using the test. The specificity of a test is the ability to correctly exclude 'negatives' who do not fit the criteria. Let's assume that we use asset profile as our standard for poverty, and we ask the question: how good is the umbrella model at identifying as vulnerable households whose asset profile is in the lowest quintile (lowest 20%) of the population? In this way, we would say that any household whose asset profile was in the lowest quintile is a 'positive', so we want to see how many of those households are included when we do vulnerability profiling, and how many households which are NOT in the lowest quintile are included as 'positives' by the umbrella model.

We can compare this with standard demographic profiling, which would identify as ‘vulnerable’ any household which is either landless, female headed, which has a person with disability or an older person.

Table 2: Comparison of Umbrella Model with Combined Standard Demographic Profiling

Method→ Measure	Umbrella model	Standard demographic profiling
Sensitivity	54%	80%
Specificity	84%	5.2%
F-test	0.57	0.08

Overall, using the umbrella model, of 1,114 households with asset profile in the lowest quintile, 572 were identified as vulnerable using the umbrella model-a sensitivity of 54%. However, of the number of households identified as vulnerable but whose asset profile was NOT in the lowest quintile was relatively low (585) giving a specificity of 84%. Overall, the F-test (a measure of the performance of the test) was calculated at 0.57-not great, but a reasonable fit. This compares well with standard profiling, which has a much lower sensitivity and specificity, and hence a lower F-test. This tells us that demographic profiling is likely to miss a number of households which are poor, but which do not fit standard profiles.

The main problem with multiple factors to profiling is that we tend to include too many people, and so have very low specificity. If we compare using a series of individual profiles (PwD, Female Headed Household, Older Person, Landless) and ask the question: if we choose people on the basis that the household has a PwD/Older person, or is female-headed, or landless, what is the likelihood that we will successfully identify the poorest households (as defined by having asset profile in the lowest quintile)? Will we leave out a large proportion of people who should be included? Would we include some people who were not considered the poorest households (this is essentially what we mean by sensitivity and specificity)?

If we compare the relative sensitivity, specificity, positive predictive value (the likelihood that a household is actually poor, if included in the list by the selection criteria) and the F-test, we can see that the selection criteria most likely to accurately include the poorest households, and correctly exclude households which are not the poorest, is using landlessness as the main criteria.

Table 3: Comparison of different Demographic Factors for profiling

	PwD	Female Headed	Older Person	Landless
Sensitivity	34%	36%	35%	69%
Specificity	67%	79%	53%	75%
Positive Predictive Value	20%	29%	15%	40%
F-test	0.25	0.32	0.21	0.50

In the umbrella model, do some factors influence the likelihood of being classified as vulnerable more than others?

In any model with multiple factors, it is important to determine whether any individual factors have an unequal influence over a final outcome. For example, we can construct models to determine the influence of age, height and weight on blood pressure, and determine which of these three factors

are more likely to influence blood pressure. In the same way, with the umbrella model, we need to determine whether some factors gave inordinate influence on the final classification of vulnerability.

This is useful for several reasons. Firstly, it can help evaluate whether the model has a good ‘fit’: meaning, are all the factors reasonably equal in their influence on vulnerability, or are the results heavily skewed by extreme variables in one or more of the factors. Secondly, in terms of application, this analysis can help us determine whether certain factors do have more influence, and if so, then we can estimate the likely impact on overall vulnerability of modifying those factors (for example, improving livelihood diversity). This can be analyzed for sub-groups: for example, we can see whether poor asset profile is a stronger influence on vulnerability amongst female headed households. This can then give us some clues as to what may be the most beneficial to focus on in our vulnerability reduction strategies. A word of caution: the big assumption when applying the umbrella model is that the model truly reflects reality. In other words, that when we identify a household as ‘vulnerable’ according to the model, that they are in fact likely to be more vulnerable. This can only really be proven with long-term studies looking at the impact of different hazards on different types of households-and this raises some ethical issues about not intervening when we see that vulnerability does exist. However, the assumption is further tested when we consider the likely impact of changing variables. So, if we improve the livelihood diversity status of a household, so that they move from being ‘vulnerable’ to ‘not vulnerable’ does that in fact reflect their actual situation? Again, we have no evidence to confirm this, and therefore need to make an assumption, based on other studies, that in most situations, improving livelihood diversity does in fact reduce vulnerability. This again underscores the caution with using any model: there will always be certain assumptions which can only be practically proved or disproved. Hence, we need to exercise some caution when reading into the results of analysis of any tool measuring poverty or vulnerability.

Practically, there are two ways to measure the overall influence of a single factor on overall vulnerability status. The first method is simple exclusion, which examines the rate of change in vulnerability classification when a certain factor is eliminated from the model. This is straightforward, but has some problems given that the classification of vulnerability is non-linear (you either are vulnerable or not) based on having more than two vulnerable factors, and excluding one factor also reduces the probability of scoring more than two. However, we can nonetheless estimate the percentage reduction in vulnerability when each factor is removed from the model:

Table 4: Relative influence of different factors in the umbrella model on overall vulnerability

	% reduction in vulnerability when factor is removed
Dependents	15.17
Indebtedness	15.17
Income	16
Livelihood diversification capacity	14.59
Food Security	16.92
Water & Sanitation	20.81
Health	24.05
Assets	21.39
Social Participation	18.08
Decision making	17.91

A more statistically reliable approach to measuring the relative contribution of each factor (variable) to the overall classification of vulnerability is to construct a multiple logistic regression

model, and then evaluate the impact value of each factor in turn on the overall classification of vulnerability. Using this approach, we can estimate the overall vulnerability score by an equation which multiplies the household score in each factor by the impact value of each factor.

This becomes $y = m^1x^1 + m^2x^2 + m^3x^3 + \dots + b$, where m is the impact factor and x is the score in each factor. Y is the overall vulnerability score, and b is the constant.

Essentially, what the regression model does is to look at the impact on the whole model of changing one of the variables (factors) assuming that there is no relationship between one factor and another.

The outcome of the regression model allows us to see the amount of change in each factor which would result in a change in status of vulnerability. This can show us the extent to which changes in certain factors can influence vulnerability. We can also test to see if these findings are statistically significant.

Firstly, we assess the overall 'fitness' of the model, which tells us the degree to which changes in the variables are linked with changes to the overall status. Not surprisingly, there is reasonable 'fit' with an R-coefficient of 0.39 for simple vulnerable/not status and R-co-efficient of 0.58 when looking at the impact of factors on the overall score for number of vulnerable factors.

When looking at the point change required to influence overall status, we can see that each of these are expressed as a negative number. This shows that a REDUCTION in score is associated with an increased likelihood of being considered vulnerable, which is how the model works. Reading the scores we can say, for example, that a reduction in the income score of 0.4 is required to result in a significant change in the overall vulnerability status, whereas a smaller change (-0.122) in decision making will have the same effect. This is largely a reflection of the way in which scores are distributed. If scores are widely distributed, meaning that we have a good spread of high, medium and low scores, then the point change needed to influence vulnerability status will be higher. In some factors, however, the differences in scores between households was quite minimal, and so a small change in the score for that factor would have a significant impact on overall vulnerability. Again, this leads to the question of 'Does this really matter in reality?'. In other words, if we address issues of decision making so that household scores improved, and then those households were no longer considered vulnerable, would that actually mean that they were, in real life, not vulnerable any more? The answer would be...yes, in a way, because clearly, in real life, lack of participation in decision making is known to be linked with increased vulnerability. But the complexity of vulnerability means that there may also be other factors which are also needed to address vulnerability.

Table 5: relative influence of different factors on overall vulnerability, using linear estimates in a multifactor regression model

	Point change required to influence overall status	Statistical significance
Dependents	-0.209	<0.001
Indebtedness	-0.41	<0.001
Income	-0.4	<0.001
Livelihood diversification capacity	-0.359	<0.001
Food Security	-0.136	<0.001
Water & Sanitation	-0.489	<0.001
Health	-0.1904	<0.001
Assets	-0.3317	<0.001
Social Participation	-0.2027	<0.001
Decision making	-0.122	<0.001

In later chapters, we will be able to analyze the extent to which the influence of different factors changes with different types of household. For example, is asset profile a more significant influence on vulnerability amongst women-headed households?

What is the typical profile of a household classified as vulnerable?

When we compare households classified as vulnerable as those that are not, we can see that vulnerable households are more likely than non-vulnerable households to be female-headed, to have a member who has a disability and to have an older person in the house, and typically would own smaller amounts of land (or none at all) compared to non-vulnerable households.

Table 6: Profile of vulnerable households

	Vulnerable	Not
Household members (average)	4.8	5.1
Age of Household head	50.39	51.15
% female headed	26.6%	22.3%
% with person with disabilities	20.2%	16.0%
% with older person	38.4%	36.4%
Number of dependents	2.17	1.85
Average number of income sources	2.35	2.77
% expenditure on food	33.5%	31.8%
% expenditure on debt	16.5%	11.5%
% of debt owned by money lenders	30.5%	21.7%
average # land acres owned	1.33	1.99
Average days lost per income generating member to ill health	11.64	2.99

Vulnerable households have a higher number of dependents, fewer income sources, a higher proportion of expenditure on food and debt, a higher percentage of debt owned by high-risk creditors such as money lenders, and a much higher average number of days lost per income-generating member than non-vulnerable households. Interestingly, the average number of household members was slightly lower for vulnerable than non-vulnerable households, and the average age of household head was lower for vulnerable than non-vulnerable. In fact, there is clear linear relationship between the age of household head and vulnerability, where increasing age is associated with a commensurate decrease in vulnerability.

How does this profile compare with households classified as poor?

Taking our current criteria for classifying as household as poor(asset profile in the lowest quintile) we can see that poor households have a similar profile compared with households classified as vulnerable, with fewer household members, a higher percentage being female headed, a higher percentage of households with members with disabilities or older persons, and a higher proportion of income spent on food and debt servicing. The only noticeable differences are a narrowing of the difference in percentage of debt owed to money-lenders and a much smaller difference in the average days lost per income generating household member. This is an expected difference, given the way that the vulnerability model is constructed. However, poor households had fewer

dependents than non-poor, although this difference disappeared when corrected for number of household members.

Overall, this comparison indicates that the profile for poor and vulnerable households overlap considerably, demonstrating that households identified as vulnerable are likely to be poor, and to have the same profile as poor households, but that additionally, some non-poor households may be identified by this model, which is precisely the purpose of the vulnerability model, being designed to identify households 'at risk' of poverty as well as those already poor.

Table 7: Profile of households classified as poor

	Poor	Not
Household members (average)	3.9	5.3
Age of Household head	50.19	51.16
% female headed	35.6%	20.4%
% with person with disabilities	20.1%	16.3%
% with older person	18.1%	16.5%
Number of dependents	1.62	1.99
Average number of income sources	2.21	2.79
% expenditure on food	31.1%	32.4%
% expenditure on debt	14.7%	12.1%
% of debt owned by money lenders	25.0%	23.4%
average # land acres owned	0.64	2.14
Average days lost per income generating member to ill health	6.47	4.56

However, these two profiles also demonstrate the point being made earlier in the paper-that only a proportion of households with persons with disabilities, older persons or female headed households are poor or vulnerable.

Category	% Poor	% Vulnerable
Woman headed households	41	40
Households with PwD	29	45
Households with OP member	26	42

This demonstrates that although demographic profiling can have some value, it will still tend to result in lower overall positive predictive value than multi-factorial vulnerability profiling.

How can the Umbrella Model be used to predict the likely impact of interventions designed to reduce vulnerability?

We can also now turn to looking at the influence of different interventions on overall vulnerability as a way of applying the model to predictive analysis. This essentially requires us to construct theoretical models about how certain interventions (e.g. assisting vulnerable households to have an additional livelihood) could impact overall vulnerability. This can be considered for all vulnerable households, and also for targeting specific sub-groups (such as vulnerable households with persons with disabilities). To do this, we need to first look and see if there are linear relationships between any specific demographic factors and on vulnerability. Note that a lack of LINEAR relationship does not mean that there is NO relationship between two factors. Linear relationship is a statistical

estimate of the extent to which changes in one (independent) variable will affect the other (dependent) variable. If we establish that there is a linear relationship between a certain factor (let's say the education status of the household head) and another variable (say, decision making) we may then need to see whether that relationship is linked to other factors (for example, gender of household head). Using various tests of fit, we examined whether there was any statistically significant linear associations between certain independent demographic variables and dependent variables such as asset profile or decision making. In the overall sample, no such statistically significant linear associations were demonstrated for a variety of demographic profiles, including presence of a person with disabilities, older persons, female headed household, land tenure and education status of household head. Now, as we said before, this does not mean that there is NO association between these demographic factors and issues such as asset profile; but that if there is a relationship, it is not linear. In other words, there is no matching increase (or decrease) in asset profile for every increase in the household head education score, for example. However, using other tests (which we will look at when we look at sub-groups) we may be able to show how the profile of a certain group (e.g. households with persons with disabilities) is different from others-but for now, we can say that any such difference cannot be expressed as a linear relationship.

The model can also be used to look at the possible impact of certain interventions on the overall numbers of those considered vulnerable. We will look in more detail in the following chapters at the potential impact of specifically targeted interventions (for example, health care for older persons). Here, we will briefly look at the projected impact of two community-level interventions: improved water supply and food banks. WE assume that improved water supply would result in a reduction in water/sanitation related vulnerability by reducing the proportions of people who spend large amounts of their time (or income) in obtaining water. If we assume that the impact of improved water supply will be that in the target population, the maximum time required for obtaining water would be 60 minutes, we can then consider how many households would still be classified as 'vulnerable' even if water supply was OK-and hence, we can work out how many would move from 'vulnerable' status if water supply was improved. In this case, if we applied a rule that the maximum time taken for water supply was 60 minutes, we would see that overall, the number of vulnerable households is reduced from 1206 to 955- a reduction of 5% (from 24.24% to 19.19%). Likewise, if we provided food banks in villages so that no household reported more than one out of five food insecurity indicators, the overall reduction in vulnerable households would be 4.1%, from 24.24% to 20.14%. The model allows analysis of different combinations of interventions, so that the overall effect is not simply summative (meaning that, if we combined water/sanitation AND food banks, the overall effect would NOT be a 9.1% reduction).

By analyzing a key contributory factor to poverty (vulnerability to natural disaster and economic shocks), this research demonstrates a method to allow more detailed analysis of the 'pathways to poverty'. These data demonstrate the usefulness of applying the Umbrella model to measuring household vulnerability. Applying the model to a general rural population enabled accurate mapping of vulnerability profiles, and differentiation according to demographic characteristics. By doing so, the relative increase in vulnerability rates experienced by different types of households can be demonstrated.. Furthermore, application of this model enables more detailed analysis of the underlying contributory factors to household vulnerability, enabling more accurate planning and monitoring of interventions designed to reduce vulnerability and associated poverty.

The Umbrella model has potential value for application in poverty reduction projects, by enabling detailed analysis of categories and causes of vulnerability at household level, and enabling more targeted interventions based on a more robust understanding of underlying contributory factors to vulnerability. Given the flexibility of the model, allowing for the use of different indicators to better reflect local conditions, the model can be applied in a variety of settings. However, this limits the

extent to which data from one area or country is comparable with data from another, and the model remains at best a predictor of relative vulnerability of a given household or group of households as compared to others within that same area. Our sample highlighted the need to experiment further with indicators which better capture differences between households. This is particularly true of the indicators used for debt and food security, which showed heavy clustering at one end of the scale. The model requires more robust field testing in a variety of settings, and further research to identify a wider pool of suitable indicators. Finally, the model would benefit from longitudinal analysis of accuracy in predicting vulnerability, and in particular, to explore and identify more substantive connections between vulnerability measurements and poverty.

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