Disaster management: Optimisation modelling to inform emergency food storage for organisations and citizens in New Zealand

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Introduction

New Zealand (NZ), is a country subject to a wide range of extreme natural events, some of which (eg, floods and storms) may increase in frequency and severity with the effects of climate change. To improve disaster preparations, we aimed to use scenario development and linear programming to identify the lowest-cost foods for emergency storage.

Methods

We used NZ food price data (eg, from the Food Price Index) and nutrient data from a NZ food composition database (2012 version: http://www.foodcomposition.co.nz/foodfiles). Different scenarios were modelled in Excel and the R programming language (with 2000 iterations for the uncertainty analysis). For the scenario involving the achievement of nutrient constraints, these were based on values set for Australia and New Zealand.[1] Further details on all the methods are provided elsewhere.[2]

Results

A collection of low-cost canned and dried emergency storage foods were identified. From this selection the optimised foods to achieve 11,450 kJ of dietary energy per day (for men) are shown in the Table. The median purchase cost was NZ$ 2.22 per day in the baseline scenario (equivalent to US$ 1.46) (95% simulation interval = NZ$ 2.04 to 2.38). In comparison, the cost of such a collection of foods which did not require any cooking, was NZ$ 3.67 per day.

While meeting all nutrient recommendations (and not just energy) is far from essential in a disaster setting, if such nutritionally optimised foods are purchased for storage, then the cost would be higher (NZ$ 7.10 per day, see Figure for the selected items). Where a zero level of food spoilage was assumed (eg, storage by a government agency), the cost of purchasing food for storage was as low as NZ$ 1.93 per day.

Conclusions

It appears to cost very little to purchase basic emergency foods for storage in the current New Zealand setting. The lists of the foods identified could be considered by organisations who participate in disaster relief (especially civil defence) but also by citizens.

Table: Foods per person per day (with weights) included in the various emergency food scenarios as a result of the optimisation process*

Food items selected by the optimisation process	Total food weights suggested per day (g) by Scenario (providing 11,450 kJ energy per day) "EP-B" (baseline scenario)	"EP-NC" (no cooking required)	"EP-H" (all daily nutrients achieved)	"EP-NS" (no spoilage considered)
Food that requires cooking				
White flour	100*	0	0	100
Rice (white)	100	0	0	100
Pasta (dried)	100	0	0	100
Wholemeal flour	0	0	200*	0
Food that can be eaten without cooking				
Peanut butter	100	100	51	85
Sugar	100	100	14	100
Oats (whole grain, raw)	74	100	0	100
Oil (vegetable, blend)	60	30	0	60
Peas (dried) [requires sprouting]	0	100	200	0
Sultanas	0	100	0	0
Peanuts, raw	0	96	0	0
Breakfast biscuits ("Weetbix")	0	10	0	0
Peaches (canned)	0	0	200	0
Fruit salad (canned)	0	0	200	0
Apricots (canned)	0	0	200	0
Tomatoes (canned)	0	0	200	0
Sardines	0	0	183	0
Tomato sauce	0	0	145	0
Total food weights consumed per day (g) (excluding added water)	**634**	**636**	**1594**	**645**
Number of food items	**7**	**8**	**10**	**7**
Cost to purchase (NZ$)	**$2.22**	**$3.67**	**$7.10**	**$1.93**
Cost in US$ per day	**$1.46**	**$2.41**	**$4.66**	**$1.27**

* Upper weight limits per food item (eg, 100g) were applied to increase variety and lower the risk that food spoilage could eliminate some of the emergency food stockpile.

Figure: The 10 food items selected in Scenario EP-H which provides all nutritional requirements for men for a day (see Table for specific amounts per day). All of these items do not require cooking (except for the flour) and the peas would need to be soaked/sprouted. (The actual amounts of the foods in this photo actually have enough dietary energy for 4.7 days for one man).

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