**A. Supplementary Tables**

Table A.1 Summary of the different features used in this study and where we retrieved them from.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type** | **Description** | **Variables** | **Feature engineered** | **Source** |
| Livelihoodzone | **Unique ID per livelihoodzone** | 'LZCODE', |  | (FEWS NET, 2011) |
| **Dummy variable which differentiates between urban (0) area, agropastoral (1), pastoral (2), cropping (3) and NZ (unknown region; 4).** | 'LZTYPE', |  | (FEWS NET, 2011) |
| Soil moisture profile | **Soil moisture profile in fraction** | 'smp\_mean', |  | (Bolten et al., 2010; Bolten and Crow, 2012; Kerr and Levine, 2008; Mladenova et al., 2017; Sazib et al., 2018) |
| 'smp\_median', |  |
| 'smp\_mean\_RW', | X |
| 'smp\_median\_RW', | X |
| Surface soil moisture | **Subsurface soil moisture in mm** | 'ssm\_mean', |  | (Bolten et al., 2010; Bolten and Crow, 2012; Kerr and Levine, 2008; Mladenova et al., 2017; Sazib et al., 2018) |
| 'ssm\_median', |  |
| 'ssm\_mean\_RW', | X |
| 'ssm\_median\_RW', | X |
| Surface soil moisture anomaly | **Values closer to 1 is extreme wetting and -1 is extreme dry soil.** | 'ssma\_mean', |  | (Bolten et al., 2010; Bolten and Crow, 2012; Kerr and Levine, 2008; Mladenova et al., 2017; Sazib et al., 2018) |
| 'ssma\_median', |  |
| 'ssma\_mean\_RW', | X |
| 'ssma\_median\_RW', | X |
| Subsurface soil moisture | **Surface soil moisture in mm** | 'susm\_mean', |  | (Bolten et al., 2010; Bolten and Crow, 2012; Kerr and Levine, 2008; Mladenova et al., 2017; Sazib et al., 2018) |
| 'susm\_median', |  |
| 'susm\_mean\_RW', | X |
| 'susm\_median\_RW', | X |
| Subsurface soil moisture anomaly | **Subsurface soil moisture anomaly Values closer to 1 is extreme wetting and -1 is extreme dry soil** | 'susma\_mean', |  | (Bolten et al., 2010; Bolten and Crow, 2012; Kerr and Levine, 2008; Mladenova et al., 2017; Sazib et al., 2018) |
| 'susma\_median', |  |
| 'susma\_mean\_RW', | X |
| 'susma\_median\_RW', | X |
| Rain | **Merged microwave/IR precipitation estimate** | 'precipitation\_mean', |  | (Adler et al., 2003; Huffman, 2014, 1997; Huffman et al., 2007, 1997, 2001, 1995) |
| 'precipitation\_median', |  |
| 'precipitation\_mean\_RW', | X |
| 'precipitation\_median\_RW', | X |
| NDVI | **Normalized Difference Vegetation index** | 'ndvi\_mean', |  | (Google, 2020) |
| 'ndvi\_median', |  |
| 'ndvi\_mean\_RW', | X |
| 'ndvi\_median\_RW', | X |
| Elevation | **Elevation in meters** | 'elevation\_mean', |  | (Danielson and Gesch, 2011) |
| 'elevation\_median', |  |
| Accessibility | **Travel time to the nearest densely-populated area in meters** | 'access\_mean', |  | (Weiss et al., 2018) |
| 'access\_median', |  |
| Friction | **Land based travel speed in minutes per meter** | 'friction\_mean', |  | (Weiss et al., 2018) |
| 'friction\_median', |  |
| Population Count | **The estimated number of people per square kilometer** | 'popcount\_mean', |  | (Center for International Earth Science Information Network, 2018) |
| 'popcount\_sum', |  |
| Population Density | **The estimated number of persons per square kilometer** | 'popdens\_mean', |  | (Center for International Earth Science Information Network, 2018) |
| Food | **Maize retail prices per market** | 'Maize (white) - Retail KG', |  | (World Food Program, 2020) |
| 'Maize (white) - Retail KG\_diff\_price\_binary', | X |
| 'Maize (white) - Retail KG\_RW', | X |
| **Maize wholesale prices per market** | 'Maize (white) - Wholesale 100 KG', |  | (World Food Program, 2020) |
| 'Maize (white) - Wholesale 100 KG\_diff\_price\_binary', | X |
| 'Maize (white) - Wholesale 100 KG\_RW', | X |
| **Wheat retail prices per market** | 'Wheat - Retail KG', |  | (World Food Program, 2020) |
| 'Wheat - Retail KG\_diff\_price\_binary', | X |
| 'Wheat - Retail KG\_RW', | X |
| **Wheat wholesale prices per market** | 'Wheat - Wholesale 100 KG', |  | (World Food Program, 2020) |
| 'Wheat - Wholesale 100 KG\_diff\_price\_binary', | X |
| 'Wheat - Wholesale 100 KG\_RW', | X |
| **Sorghum retail prices per market** | 'Sorghum - Retail KG', |  | (World Food Program, 2020) |
| 'Sorghum - Retail KG\_diff\_price\_binary', | X |
| 'Sorghum - Retail KG\_RW', | X |
| **Sorghum wholesale prices per market** | 'Sorghum - Wholesale 100 KG', |  | (World Food Program, 2020) |
| 'Sorghum - Wholesale 100 KG\_diff\_price\_binary', | X |
| 'Sorghum - Wholesale 100 KG\_RW', | X |
| Conflict | **The low estimate consists of the aggregated low estimates of deaths for all incidents of organised violence during a year** | 'fatalities\_low', |  | (Uppsala University, 2018) |
| 'fatalities\_low\_RW', | X |
| 'fatalities\_low\_cumsum', | X |
| **Death incurred by state-based armed conflict, non-state conflict (battle-related deahts) and one-sided violence** | 'fatalities', |  |
| 'fatalities\_RW', | X |
| 'fatalities\_cumsum', | X |
| **The high estimate consist of the aggregated high estimates of deaths for all incidents of organised violence during a year** | 'fatalities\_high', |  |
| 'fatalities\_high\_RW', | X |
| 'fatalities\_high\_cumsum', | X |
| Crops | **Binary variable indicating whether a specific fruit, grain or vegetable is a main crop** | 'other roots', 'root crops', 'flax', 'sorghum', 'groundnuts', 'maize', 'chat', 'pepper', 'barley', 'rice', 'cotton', 'gesho', 'wheat', 'sugar cane', 'sesame', 'ginger', 'cassava', 'spices', 'pulses', 'teff', 'tobacco', 'nug', 'wild oats', 'enset', 'irish potatoes', 'oilseeds', 'oats', 'bananas', 'cactus fruit', 'millet', 'coffee', 'date palm', 'mixed cash crops', 'fruit/veg', 'sweet potatoes', 'taro',. |  | (FEWS NET, 2011) |
| Stock | **Binary variable indicating whether a stock is a main stock** | 'shoats', 'cattle', 'equines', 'camels', 'poultry', 'bees', |  | (FEWS NET, 2011) |
| Date | **The Belga, Kiremt and Bega season.** | 'BelgSeason', | X |  |
| 'KiremtSeason', | X |
| 'BegaSeason', | X |
| **The month the data originated from** | 'Month', |  |
| **The year the data originated from** | 'Year', |  |
| IPC | **Current food security outcomes for a specific month** | 'CS', |  | (FEWS NET, 2011) |
| 'CS-1', | X |
| 'CS-2', | X |
| 'CS-3', | X |
| 'CS-4', | X |
| 'CS-5', | X |
| 'CS-6', | X |
| **Humanitarian assistance is present and helping the area** | 'HA0', |  |
| 'HA0-1', | X |
| 'HA0-2', | X |
| 'HA0-3', | X |
| 'HA0-4', | X |
| 'HA0-5', | X |
| 'HA0-6', | X |
| **History of the livelihoodzones. How many times did any change event happen.** | 'change\_events\_count\_all', | X |  |
| **History of the livelihoodzones. How many times did an improvement happen** | 'change\_events\_count\_improve', | X |  |
| **History of the livelihoodzones. How many times did a deterioration happen.** | 'change\_events\_count\_deter' | X |  |

Table A.2 Summary of all the different markets that have been used to calculate the mean average food market price per admin zone level 1.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Addis Ababa** | **Afar** | **Amhara** | **Beneshangul**  **Gumu** | **Gambela** | **Oromia** | **SNNPR** | **Somali** | **Tigray** |
| *Addis Ababa* | *Abaala* | *Abomsa* | *Assosa* | *Gambela* | *Ambo* | *Amaro* | *Gode* | *Abi Adi* |
|  | *Asayta* | *Ajeber* |  | *Meti* | *Assela* | *Aroresa* | *Jijiga* | *Adigrat* |
|  |  | *Baher Dar* |  |  | *Babile* | *Gamo Gofa* |  | *Adwa* |
|  |  | *Bati* |  |  | *Beddenno* | *Hawassa* |  | *Alamata* |
|  |  | *Bure* |  |  | *Bedessa* | *Hossana* |  | *Hawzien* |
|  |  | *Debark* |  |  | *Deder* | *Karati* |  | *Humera* |
|  |  | *Debre Birhan* |  |  | *Delo* | *Sodo* |  | *Korem* |
|  |  | *Debre Markos* |  |  | *Derashe* | *Turmi* |  | *Mekele* |
|  |  | *Dessie* |  |  | *Gordamole* | *Wonago* |  | *Sik'ela* |
|  |  | *Ebinat* |  |  | *Jimma* |  |  | *Wekro* |
|  |  | *Gonder* |  |  | *Kersa* |  |  |  |
|  |  | *Kobo* |  |  | *Merti* |  |  |  |
|  |  | *Mota* |  |  | *Nazareth* |  |  |  |
|  |  | *Robit* |  |  | *Nekempt* |  |  |  |
|  |  | *Sekota* |  |  | *Robe* |  |  |  |
|  |  |  |  |  | *Shashemene* |  |  |  |
|  |  |  |  |  | *Wolenchiti* |  |  |  |
|  |  |  |  |  | *Woliso* |  |  |  |
|  |  |  |  |  | *Ziway* |  |  |  |

Table A.3 the hyperparameters selected after hyperparameter tuning.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Hyperparameters | | | | | |
| *Xgboost* | | *Catboost* | | *Random Forest* | |
| **n\_estimators** | 500 | **Iterations** | 1000 | **n\_estimators** | 1000 |
| **learning\_rate** | 0,005 | **Learning\_rate** | 0,001 | **max\_features** | sqrt' |
| **max Depth** | 3 | **max\_depth** | 8 | **max\_depth** | 5 |
| **subsample** | 0,7 | **l2\_lear\_reg** | 10 | **min\_samples\_split** | 2 |
| **colsample\_bytree** | 0,7 |  |  | **min\_samples\_leaf** | 1 |
| **Gamma** | 0,3 |  |  |  |  |
| **min\_chil\_weight** | 7 |  |  |  |  |
| **reg\_alpha** | 1 |  |  |  |  |
| **reg\_lambda** | 1 |  |  |  |  |

Table A.4 Summary of the different baseline models that we are going to use to validate the model

|  |  |  |
| --- | --- | --- |
| **Baseline name** | **Type** | **Definition** |
| **Dummy Classifier Stratified (DCS)** | ***Chance*** | **Generates forecasts by respecting the training set’s class distribution** |
| **Historical Norm (HN)** | ***Heuristic*** | **Mode of Change Event over the train period per livelihood zone is sufficient to predict the change event in the test period.** |
| **Future Equals The Present (FeP)** | ***Heuristic*** | **The future equals the present. In our case this means there is no change at all, since everything stays the same.** |
| **Historical Norm Temporal (HNT)** | ***Heuristic*** | **The mode of the Change event over the train period per livelihood zone per month is sufficient to predict the change event in the test period.** |
| **Recent Observation (RO)** | ***Heuristic*** | **The most recent observation for a livelihood zone for a specific month is a good forecast for the future.** |

Table A.5 Classification report over the n 100 runs for the 7-month interval.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Deterioration** | **No Change** | **Improvement** | **Overall Accuracy** | **Macro Average** |
| **f1-score** | 0.48 | 0.74 | 0.60 |  | 0.61 |
| **precision** | 0.41 | 0.87 | 0.49 |  | 0.59 |
| **recall** | 0.59 | 0.64 | 0.78 |  | 0.67 |
|  |  |  |  | 0.66 |  |

Table A.6 Classification report over the n 100 runs for the 3-month interval.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
|  | **Deterioration** | **No Change** | **Improvement** | **Overall Accuracy** | **Macro Average** |
| **f1-score** | 0.32 | 0.75 | 0.47 |  | 0.51 |
| **precision** | 0.23 | 0.91 | 0.35 |  | 0.49 |
| **recall** | 0.56 | 0.63 | 0.75 |  | 0.65 |
|  |  |  |  | 0.64 |  |

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