



# UNOSAT

## Sorland – Hurricane Windblown

### 25 September 2016

Analysis of population exposure

26 September 2016

Geneva, Switzerland

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## Overview

Hurricane Windblown formed north-east of the Atlantic Ocean on the 20<sup>th</sup> of September 2016. The hurricane intensified as it continued east. It struck the south-western region of Sorland on the 25<sup>th</sup> of September at 3.00 UTC with a wind speed of 182 km/h. The maximum wind speed of the hurricane, of 190 km/h, was reached at 9.00 UTC. At midday, the hurricane moved from the southern part of Sorland to the north decreasing in intensity.

According to the UN Resident Coordinator's Office in Sorland, a combination of unusually heavy rainfall in the first three weeks of September and the hurricane Windblown has caused a humanitarian crisis in the southern regions of Sorland.

Hundreds of thousands of people have been displaced, a malaria outbreak is looming, and severe access constraints caused by damaged and destroyed infrastructure limit humanitarian access to the affected areas, particularly to some rural areas that have been completely cut off.

## Accumulated precipitation analysis

Concerning the unusually heavy rainfall that was reported over Sorland during the first three weeks of September, UNITAR-UNOSAT monitored the accumulated precipitation situation from the 1<sup>st</sup> of September using the Global Precipitation Measurement (GPM) dataset at a spatial resolution of approximately 10km. On the 21<sup>st</sup> of September, UNITAR-UNOSAT released an estimated precipitation accumulation map related to the GPM data collected from 1<sup>st</sup> to 19<sup>th</sup> September (link to the pdf map [here](#)).

The heavy rainfall caused floods and landslides across Sorland, particularly affecting southern areas along the coast. Farsund and Lyngdal municipalities in Vest-Agder county are the most severely affected. As of 19 September, 286 mm of rain has been recorded- the highest recorded rainfall in September. Rainfall is expected to continue in the coming weeks as October is generally the wettest month of the year.

# Map of Estimated Precipitation Accumulation from 1 – 19 September 2016



## SORLAND

Rogaland - Vest Agder - Aust Agder



Analysis with GPM (Global Precipitation Measurement) Derived Data Acquired : 1 - 19 September 2016 | Published 21 September 2016

TRIPLEX 2016

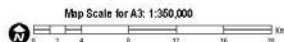
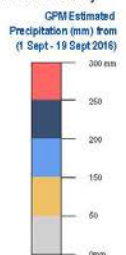


### Estimated Precipitation Accumulation

This map illustrates the estimated total precipitation accumulation for the southern part of Sorland covering the period 1-19 September 2016. This total estimate was derived from the Global Precipitation Measurement (GPM) dataset at a spatial resolution of approximately 10km, and covers the dates from 1 to 19 September 2016. It is possible that precipitation levels may have been underestimated for local areas, and is not a substitute for ground station measurements.

#### Legend

- Province boundary ( ROGA )
- Municipality boundary ( Sokndal )
- Urban area ( Hauge )
- Permanent water body



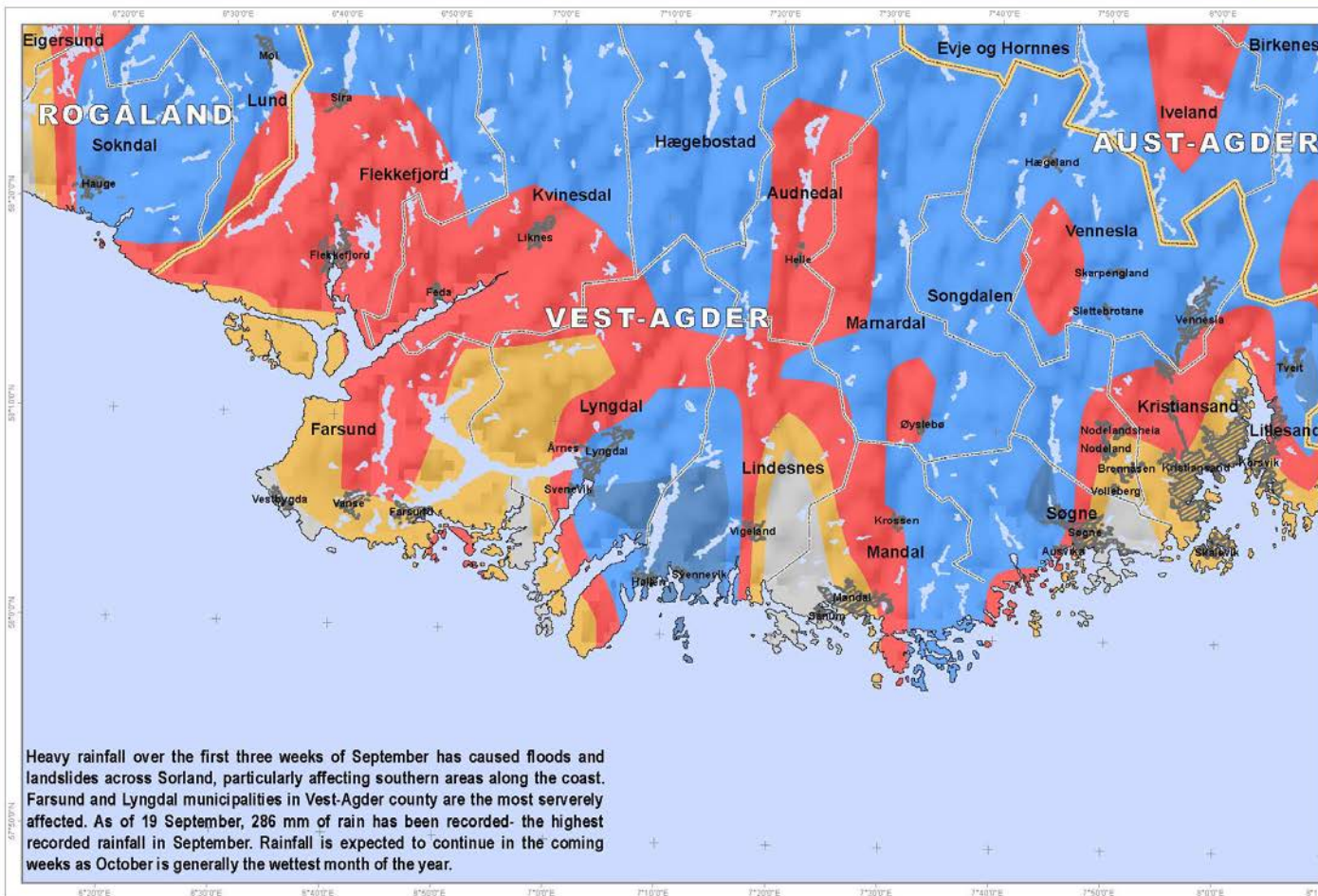
Analysis conducted with ArcGIS v10.3

Coordinate System: WGS 1984 UTM Zone 32N  
 Projection: Transverse Mercator  
 Datum: WGS 1984  
 Units: Meter

Precipitation Data: GPM  
 Resolution: ~10km  
 Date Series: 1 September to 19 September 2016  
 Copyright: NASA  
 Source: NADA

Baseline Data: Norwegian Water Resources and Energy Directorate  
 Analysis: UNITAR - UNOSAT  
 Production: UNITAR - UNOSAT

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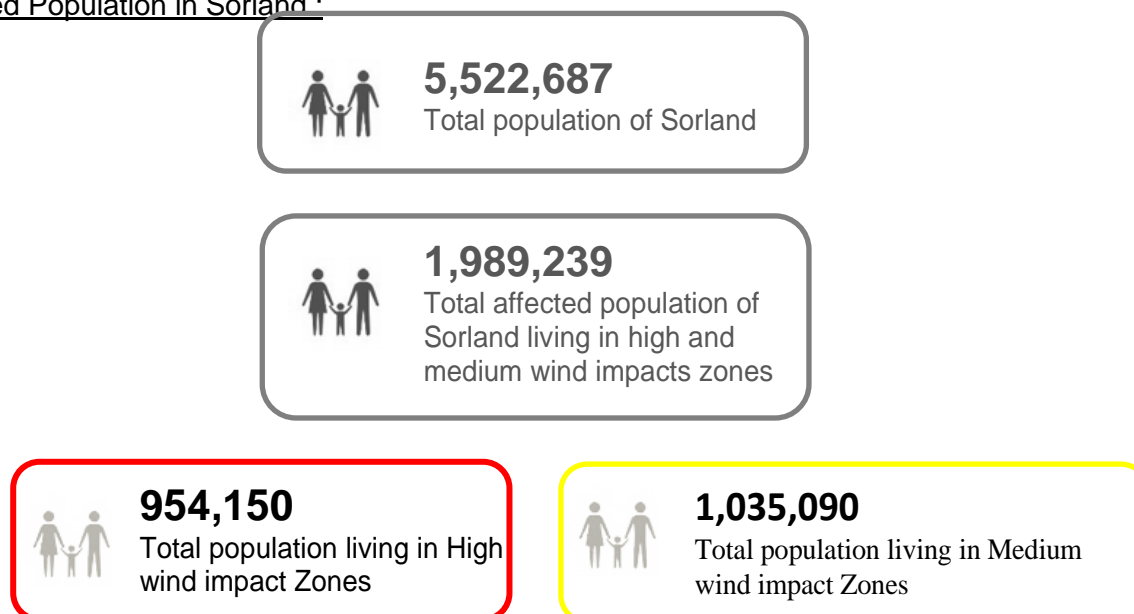
Heavy rainfall over the first three weeks of September has caused floods and landslides across Sorland, particularly affecting southern areas along the coast. Farsund and Lyngdal municipalities in Vest-Agder county are the most severely affected. As of 19 September, 286 mm of rain has been recorded- the highest recorded rainfall in September. Rainfall is expected to continue in the coming weeks as October is generally the wettest month of the year.

## Population exposure analysis

On the 25<sup>th</sup> of September 2016, following the latest information provided in Global Disaster Alert System and supporting UNDAC operations in the field, UNITAR-UNOSAT has conducted an analysis to provide information regarding the estimated population affected by the hurricane Windblown that made landfall on 25th September (3.00 UTC). The following analysis provides an overview of the magnitude of the crisis and highlights particularly vulnerable areas for humanitarian aid.

A hurricane track buffer with three classes of wind impact (High, Medium and Low), derived from hurricane track parameters provided by JTWC, was used in the analysis undertaken by UNITAR-UNOSAT to estimate the population affected. The analysis particularly focuses on the population living in municipalities of the southern part of Sorland and in the urban areas of these municipalities.

### Affected Population in Sorland:



### Affected Population Living in Medium and High Wind Speed Zones

Municipality by Province	High	Medium	Total Population Affected
<b>Aust-Agder</b>	<b>154,974</b>	<b>134,709</b>	<b>289,683</b>
Åmli		621	621
Arendal		12,096	12,096
Birkenes	20,423	9,839	30,262
Bygland	3,742	2,864	6,606
Bykle	2,837	2,176	5,013
Evje og Hornnes	14,634	7,217	21,851
Froland		7,645	7,645
Grimstad	38,344	87,086	125,430

Iveland	6,618	1,572	8,190
Lillesand	64,377	67	64,444
Valle	4,000	3,525	7,525
<b>Rogaland</b>	<b>7,561</b>	<b>37,542</b>	<b>45,103</b>
Eigersund		8,850	8,850
Hjelmeland		3	3
Lund	22	2,240	2,262
Sauda	543	8,495	9,038
Sokndal	1,598	13,302	14,900
Suldal	5,398	4,652	10,050
<b>Vest-Agder</b>	<b>791,614</b>	<b>862,839</b>	<b>1,654,453</b>
Åseral	1,008	2,109	3,117
Farsund	648,859	150,633	799,492
Flekkefjord	8,163	13,473	21,635
Kristiansand	101,204	423,990	525,194
Kvinesdal		2,158	2,158
Lindesnes	2,926	8,444	11,370
Lyngdal	14,485	85,949	100,434
Mandal	10,649	65,832	76,481
Marnardal		678	678
Søgne	2,612	55,022	57,634
Sirdal		726	726
Songdalen		4,509	4,509
Vennesla	1,707	49,317	51,024
<b>Grand Total</b>	<b>954,150</b>	<b>1,035,090</b>	<b>1,989,239</b>

Download complete excel table from [here](#)

#### Affected urban population in Sorland :



**2,924,230**

Total urban population in Sorland



**1,176,007**

Total affected urban population of Sorland living in high and medium wind impacts zones



**583,751**

Total urban population living in High wind impact Zones



**592,256**

Total urban population living in Medium wind impact Zones

## Affected Urban Population in Medium and High Wind Speed Zones

Municipality by Province	High	Medium	Total Urban Population Affected
<b>Aust-Agder</b>	<b>73,729</b>	<b>63,638</b>	<b>137,367</b>
Åmli		311	311
Arendal		5,927	5,927
Birkenes	9,394	4,526	13,920
Bygland	1,721	1,317	3,038
Bykle	1,333	1,023	2,356
Evje og Hornnes	7,170	3,536	10,707
Froland		3,593	3,593
Grimstad	18,022	40,930	58,952
Iveland	3,309	786	4,095
Lillesand	30,901	32	30,933
Valle	1,880	1,657	3,537
<b>Rogaland</b>	<b>3,580</b>	<b>18,002</b>	<b>21,583</b>
Eigersund		4,336	4,336
Hjelmeland		2	2
Lund	10	1,053	1,063
Sauda	250	3,908	4,158
Sokndal	783	6,518	7,301
Suldal	2,537	2,186	4,723
<b>Vest-Agder</b>	<b>506,441</b>	<b>510,616</b>	<b>1,017,057</b>
Åseral	494	1,033	1,527
Farsund	421,758	97,911	519,669
Flekkefjord	4,000	6,601	10,601
Kristiansand	62,747	262,873	325,620
Kvinesdal		1,036	1,036
Lindesnes	1,404	4,053	5,457
Lyngdal	8,836	52,429	61,265
Mandal	5,112	31,599	36,711
Marnardal		312	312
Søgne	1,306	27,511	28,817
Sirdal		363	363
Songdalen		2,209	2,209
Vennesla	785	22,686	23,471
<b>Grand Total</b>	<b>583,751</b>	<b>592,256</b>	<b>1,176,007</b>

Download complete excel table from [here](#)

Within the population exposure analysis, UNITAR-UNOSAT analyzed Sorland's potential affected urban areas. The results show a total number of 48 affected urban areas (14 in high wind speed zones and 34 in the medium wind speed zones). The Vest-Agder province seems to be the most affected in terms of urban areas.

## Number of Urban Areas in Medium and High Wind Speed Zones

Municipality by Province	High	Medium	N° Urban Areas Affected
<b>Aust-Agder</b>	<b>8</b>	<b>5</b>	<b>13</b>
Birkenes	2		2
Bygland	1		1
Bykle	1	1	2
Evje og Hornnes	1		1
Grimstad		3	3
Lillesand	2		2
Valle	1	1	2
<b>Rogaland</b>	<b>0</b>	<b>2</b>	<b>2</b>
Eigersund		1	1
Sokndal		1	1
<b>Vest-Agder</b>	<b>6</b>	<b>27</b>	<b>33</b>
Farsund	3		3
Flekkefjord		1	1
Kristiansand	1	7	8
Kvinesdal		1	1
Lindesnes	2	4	6
Lyngdal		4	4
Mandal		3	3
Søgne		2	2
Songdalen		3	3
Vennesla		2	2
<b>Grand Total</b>	<b>14</b>	<b>34</b>	<b>48</b>

## Map of the Hurricane Path and Wind Speed Zones (link to the pdf map [here](#))



**unitar**  
United Nations Institute for Training and Research

# SORLAND

Rogaland - Vest Agder - Aust Agder

Analysis of hurricane Windblown's path and wind impact zones (20th - 26th September 2016) | Published 25th of September 2016



Hurricane

TRIPLEX 2016



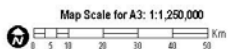


### Hurricane Path and Related Wind Impact Zones

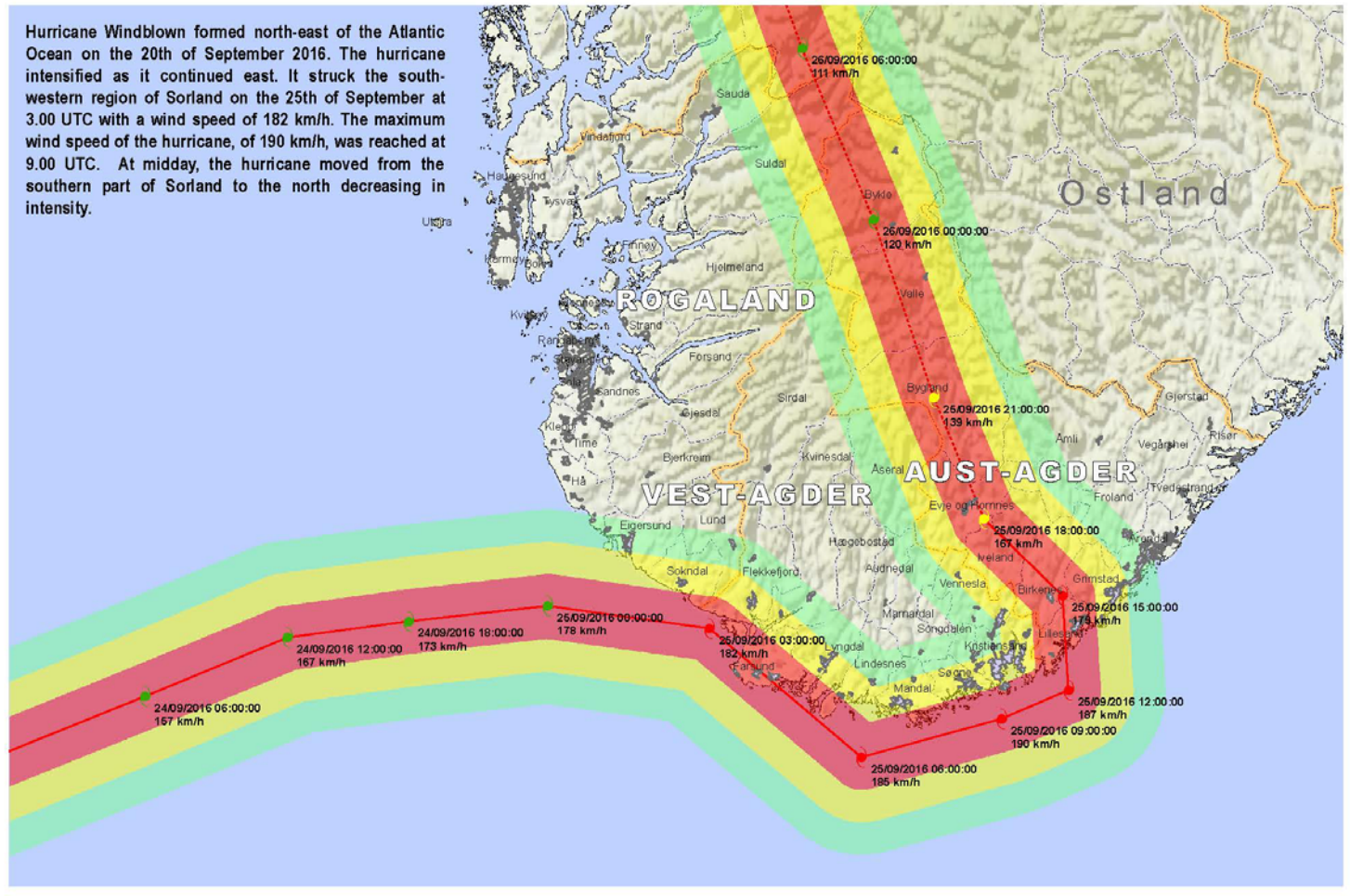
This map illustrates the hurricane Windblown's path with high, medium and low wind impact zones observed between the 20th and 25th September. The hurricane path and wind speed zones were derived from the US Navy Joint Typhoon Warning System dataset. This is a preliminary analysis and has not yet been validated in the field. Please send ground feedback to UNITAR-UNOSAT.

#### Legend

- |   |   |
|---|---|
| <p><b>Hurricane Wind Speed Alert</b></p> <ul style="list-style-type: none"> <li><span style="color: red;">●</span> High</li> <li><span style="color: yellow;">●</span> Medium</li> <li><span style="color: green;">●</span> Low</li> </ul> <p><b>Hurricane Track</b></p> <ul style="list-style-type: none"> <li><span style="color: red;">—</span> Recorded track</li> <li><span style="color: red;">- - -</span> Predicted track</li> </ul> <p><b>Administrative Boundaries</b></p> <ul style="list-style-type: none"> <li><span style="border-bottom: 1px solid orange;"> </span> Province boundary</li> <li><span style="border-bottom: 1px solid grey;"> </span> Municipality boundary</li> <li><span style="background-color: grey; width: 10px; height: 10px; display: inline-block;"></span> Urban area</li> <li><span style="background-color: blue; width: 10px; height: 10px; display: inline-block;"></span> Permanent water body</li> </ul> | <p><b>Wind Impact</b></p> <ul style="list-style-type: none"> <li><span style="background-color: red; width: 15px; height: 15px; display: inline-block;"></span> High</li> <li><span style="background-color: yellow; width: 15px; height: 15px; display: inline-block;"></span> Medium</li> <li><span style="background-color: green; width: 15px; height: 15px; display: inline-block;"></span> Low</li> </ul> |
|---|---|



Analysis conducted with ArcGIS v10.3  
 Coordinate System: WGS 1984 UTM Zone 32N  
 Projection: Transverse Mercator  
 Datum: WGS 1984  
 Units: Meter



Wind Speed Data: US Navy Joint Typhoon Warning Center  
 Date Series: 20th - 26th of September 2016  
 Copyright: NASA  
 Source: NASA

Baseline Data: Norwegian Water Resources and Energy  
 Analysis: UNITAR - UNOSAT  
 Production: UNITAR - UNOSAT

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