Golovin, Alaska (Photo by Toby Anungazuk, November 2011)

DGGS November 2011 Bering Sea Storm Rapid Response fieldwork

Nicole Kinsman
Coastal Geologist, Alaska Division of Geological & Geophysical Surveys

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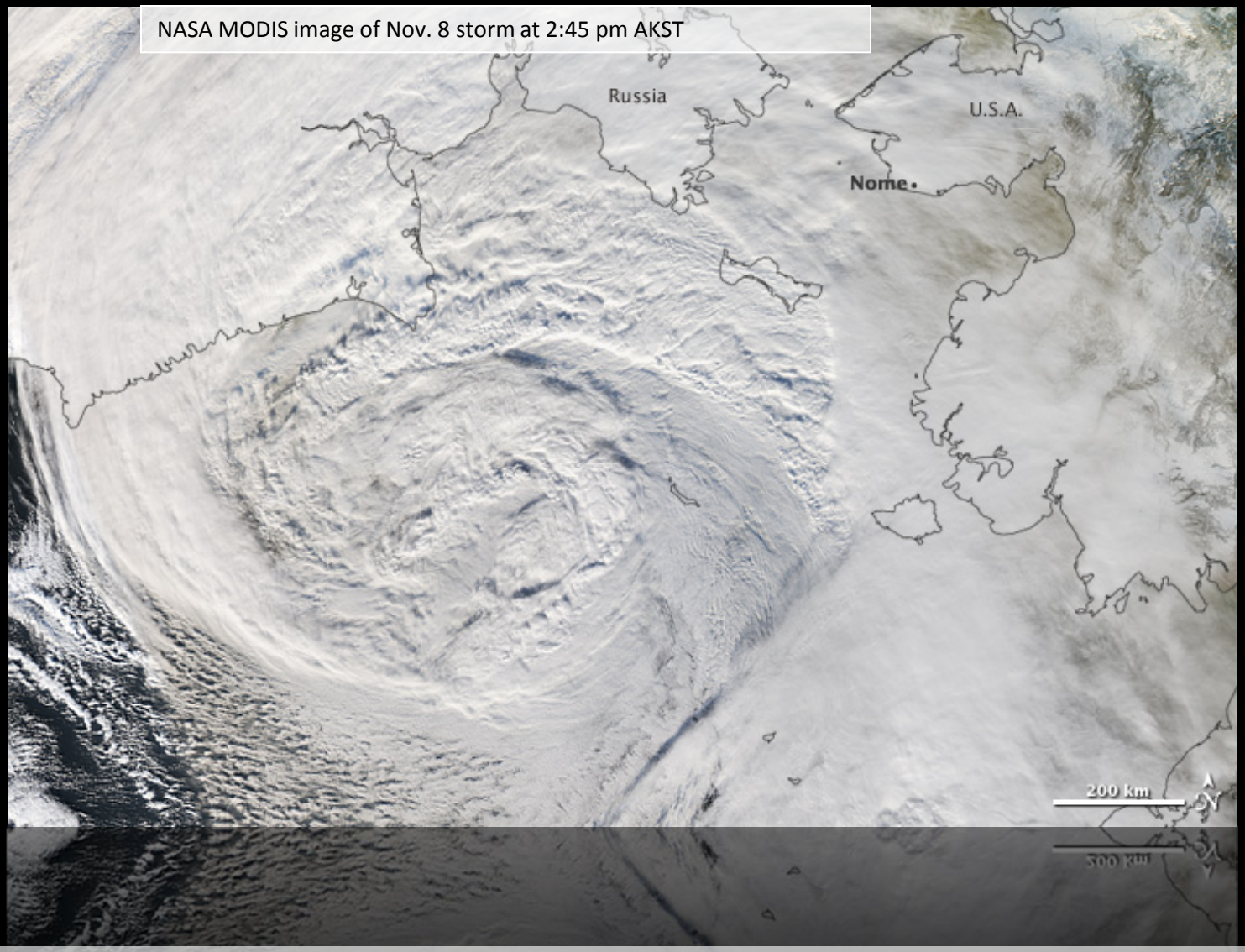
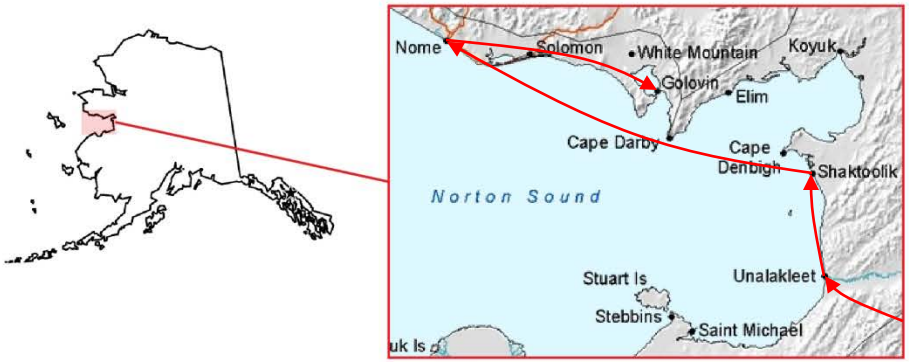
March 13, 2013
AWRA ----Brown Bag Talk



- November 8, 2011
- Non-tropical cyclone with a low of 945 millibars (comparable to Class III hurricane)
- High winds (gusts of up to 85 mph)
- Surge of ~3 meters (10 feet) to parts of Norton Sound

DGGS Response November 10-15

- On site less than 24 hours after storm surge
  - 2 days in Unalakleet
  - 2 days in Shaktoolik
  - 1 day in Nome
  - 1 day in Golovin
- Used professional-grade GPS to document
  - 20 post-storm coastal profiles
  - >50 storm-induced water levels
- Used a range of techniques to determine various ocean surface heights such as storm surge and wave run-up elevations
- Collected photographs, video and eyewitness accounts from community residents



Nov. 7 | Nov. 8 | Nov. 9 | Nov. 10 | Nov. 11 | Nov. 12 | Nov. 13 | Nov. 14 | Nov. 15 | Nov. 16 | Nov. 17

NWS Storm Announcement 7:15 AM

Peak WInds 1:42 AM

Peak Surge in Nome 5:00 PM

DGGS to UNK

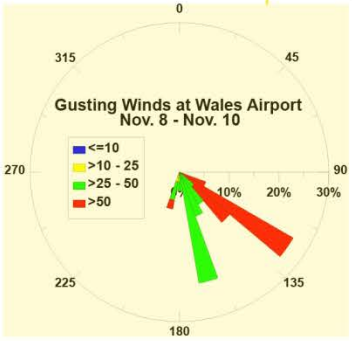
Coast Guard Flight

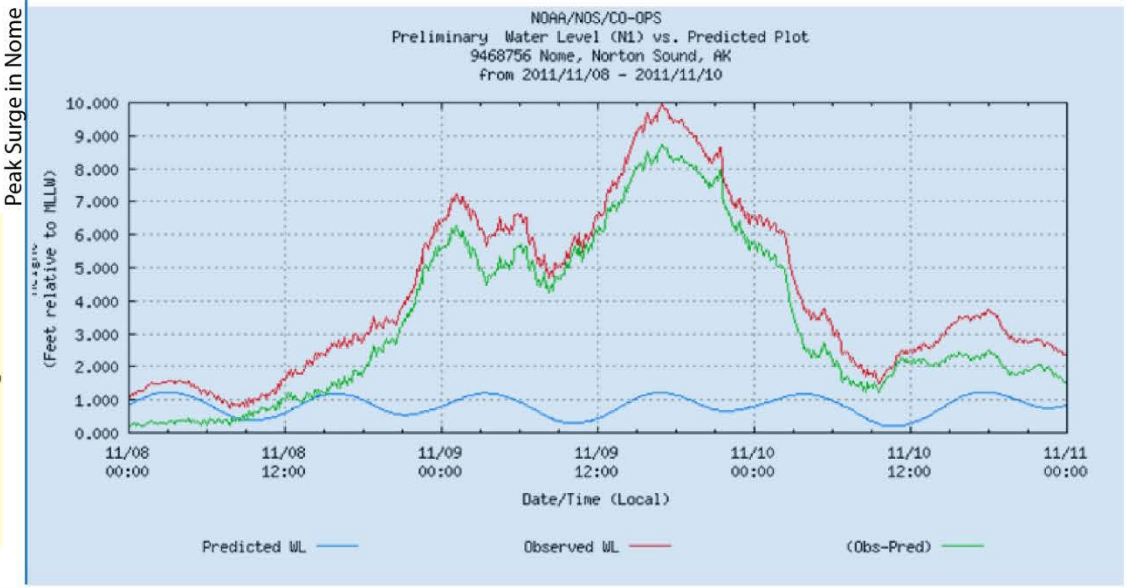
DGGS to SKK

DGGS to OME

DGGS to GLV

FEMA to GLV





NOAA49 PAFG 071615
PNSAFG
AKZ207>214-080415-

PUBLIC INFORMATION STATEMENT
NATIONAL WEATHER SERVICE FAIRBANKS AK
715 AM AKST MON NOV 7 2011

...PUBLIC INFORMATION STATEMENT...

THE STRONGEST STORM TO COME TO THE BERING SEA IN SEVERAL YEARS IS FORECAST TO CROSS THE WEST END OF THE ALEUTIAN ISLANDS LATE TONIGHT...AND TO REACH BERING STRAIT WEDNESDAY MORNING.

THIS STORM IS REMARKABLY SIMILAR TO THE GREAT BERING SEA STORM AND COASTAL FLOOD OF NOVEMBER 11 AND 12 IN 1974. THE MAIN IMPACT OF THIS YEARS STORM WILL BE COASTAL FLOODING

Methods

Equipment:
2 Topcon HiPer II receivers

Project Control:
Benchmark locations selected based on

1. Proximity to town / ease of access
2. Line of sight for RTK

Static occupations with OPUS solution

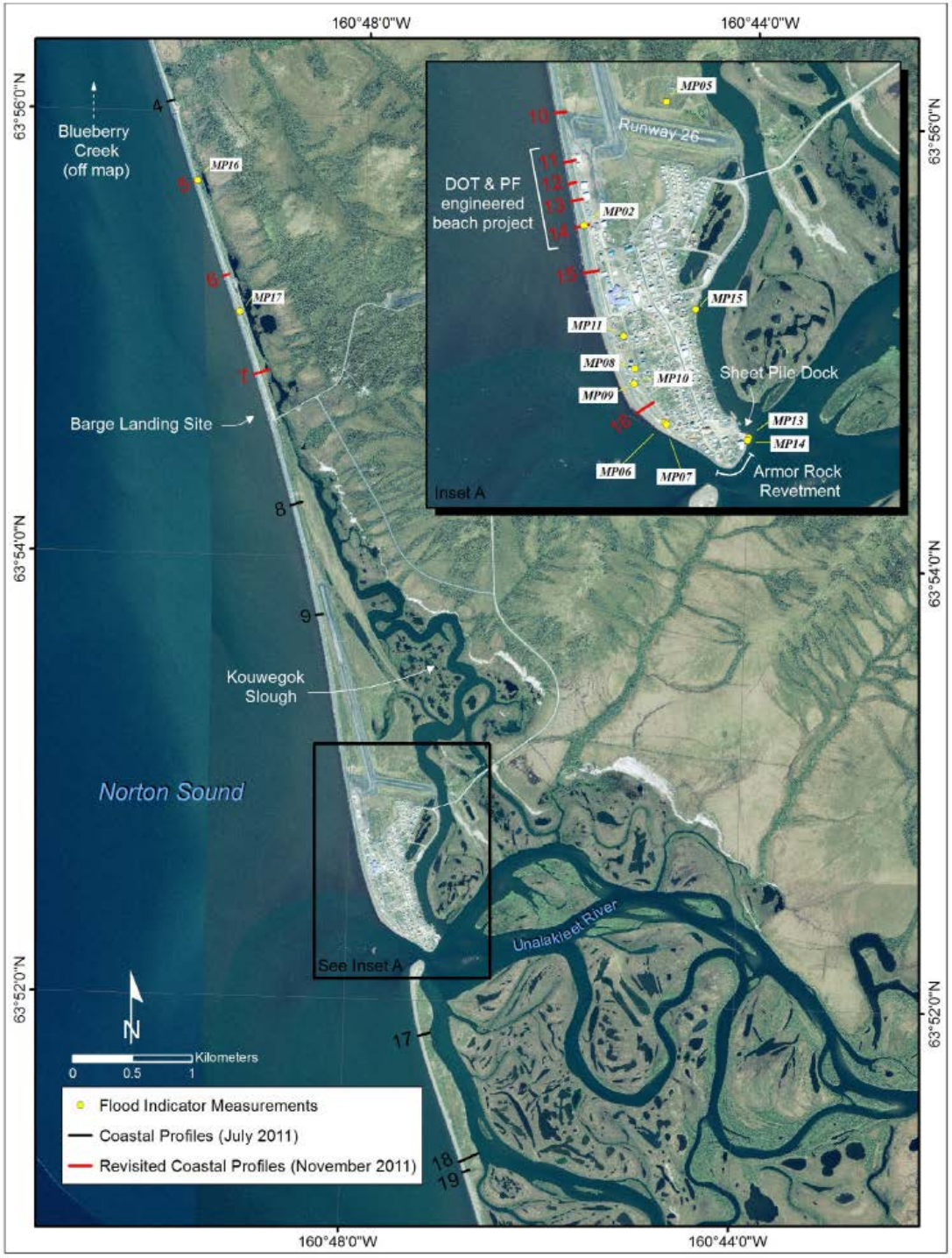
UNALAKLEET

In two days:

- Reoccupied 9 coastal profiles
- Measured 20 inundation extents
- Collected photos & video from residents

Limited flooding up to raised road along front of community, not perceived by all residents to be worse than previous 2000-era storms.

Blow-out occurred of gabion revetment at inlet mouth.



Blow-out of UNK Revetment

Unalakleet raised road

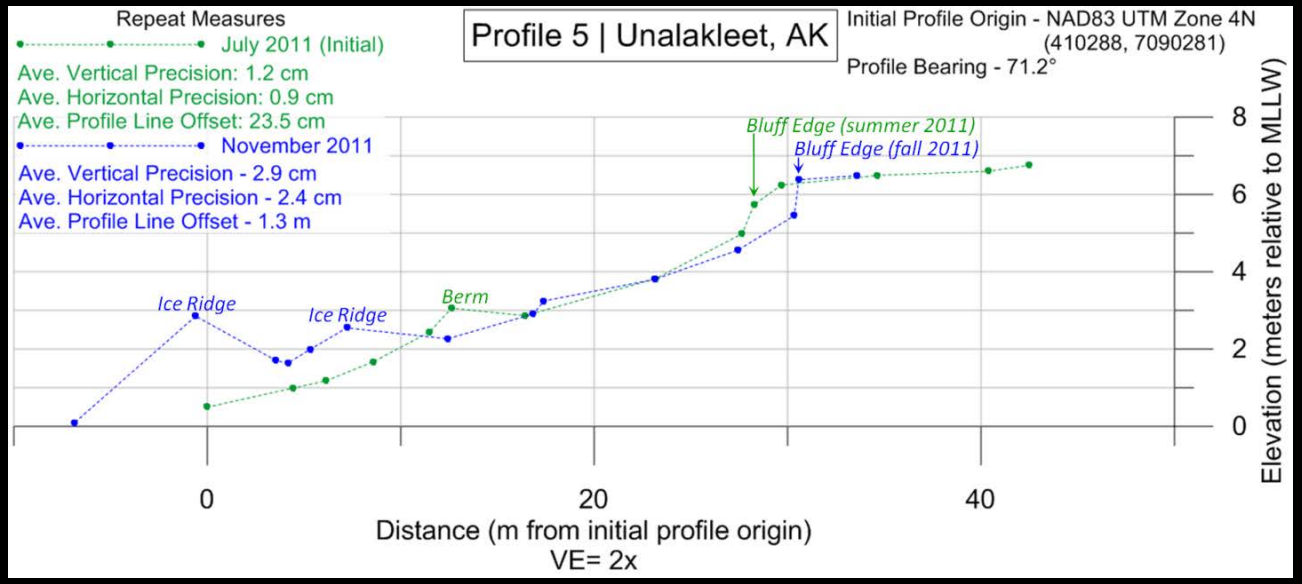
Steve Ivanoff

Flooding in UNK

Overtopping of airport road in UNK

July 2011

November 2011



⬅ 2.3 meters of bluff retreat

All repeat coastal profiles are included in the appendix to final report

SHAKTOOLIK

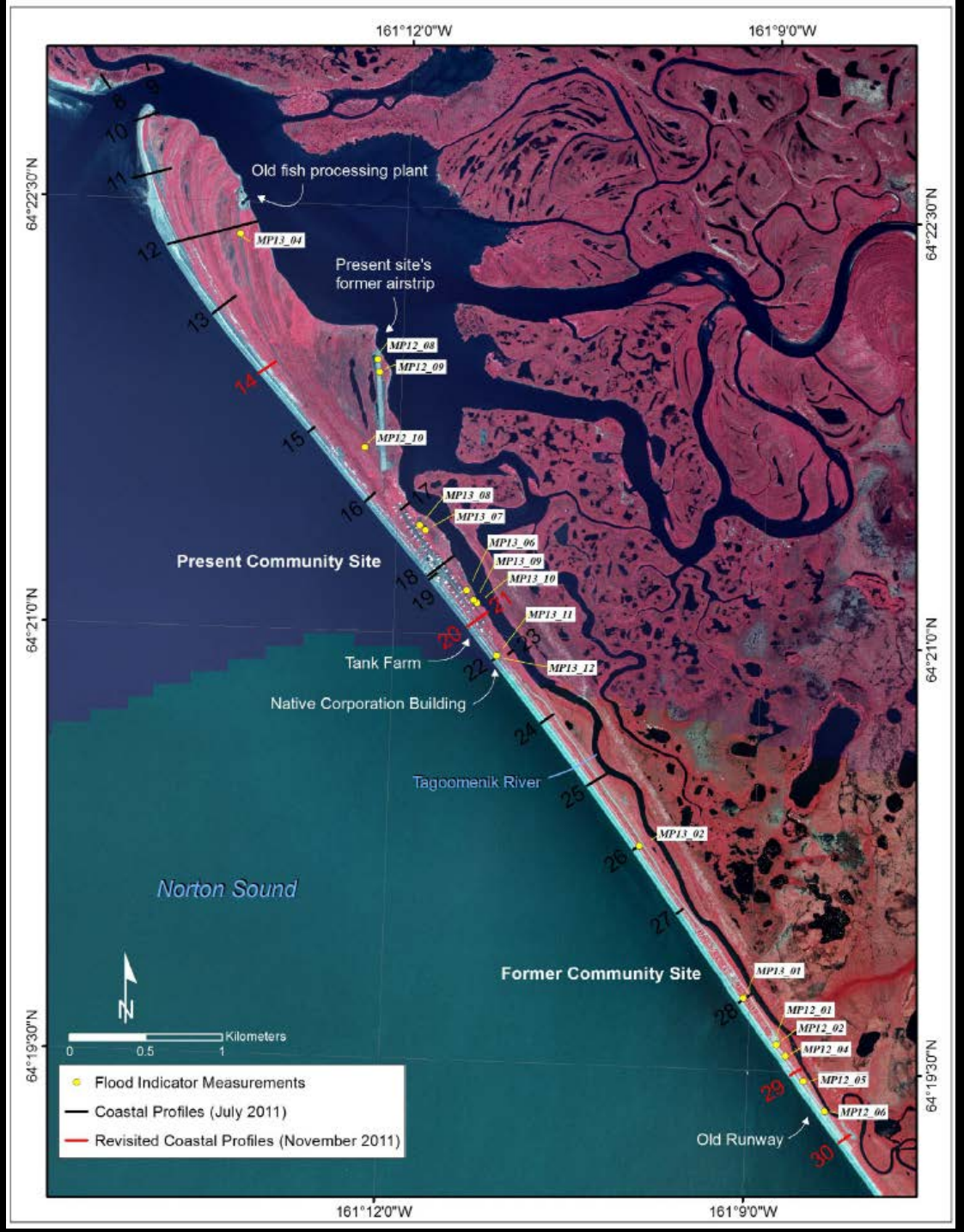
In two days:

- Reoccupied 5 coastal profiles
- Measured 13 inundation extents
- Collected photos & video from residents

Limited flooding, with more concern on the Tagoomanick River side of the community than on the sea-side due to an ice jam that caused water to back up in the river.

Some overtopping of old storm deposits on sea-side and one area of overwash near old community. Significant notching of coastal bluffs at old community site.

Perceived by most residents to be worst event at new site (moved there post ’74 storm).



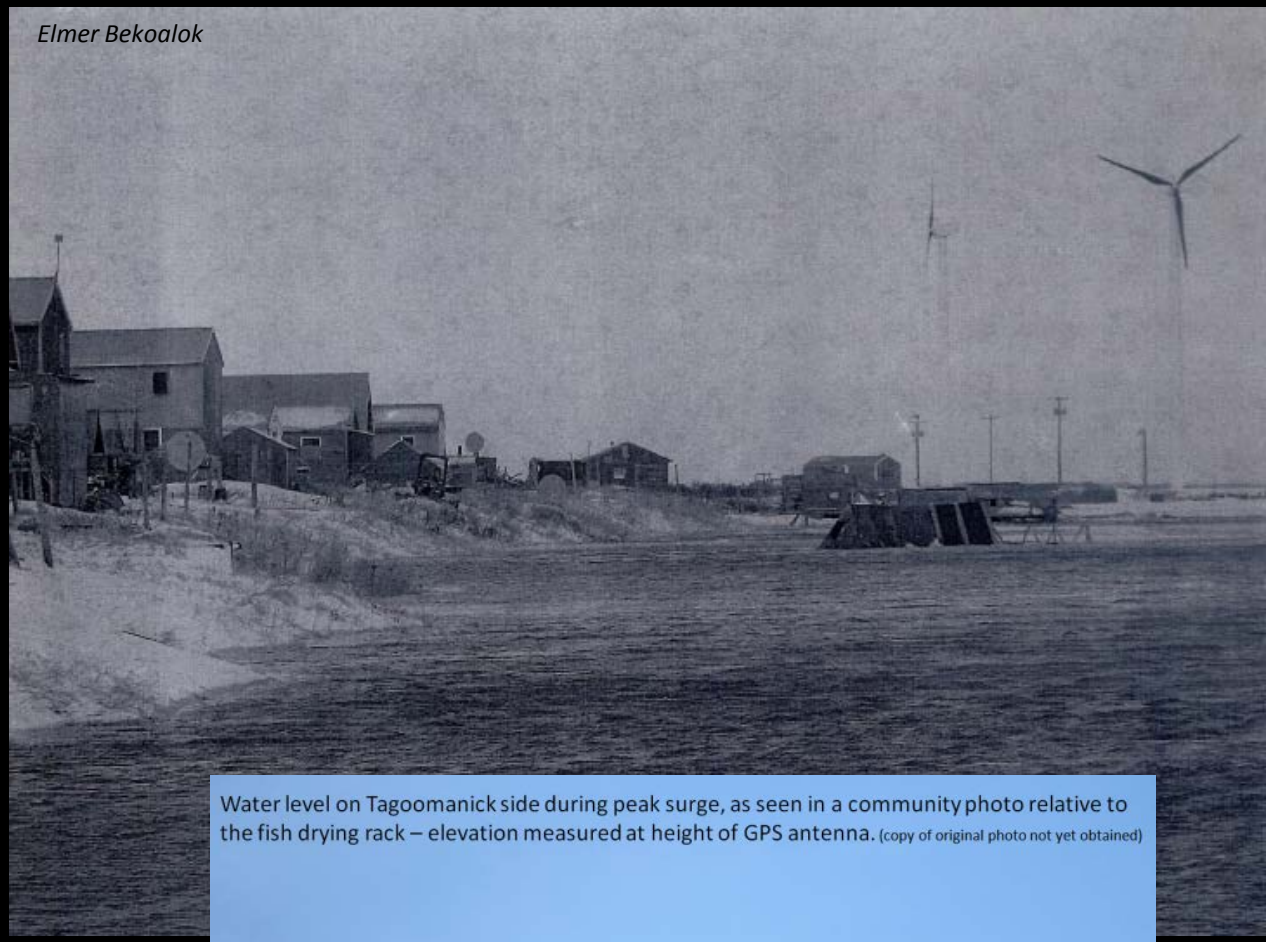
Wave attack in front of Shaktoolik

Video by Shawn Hulse – November 2011

Flooding on Tagoomanik River


Elmer Bekoalok


Elmer Bekoalok


Elmer Bekoalok

Water level on Tagoomanick side during peak surge, as seen in a community photo relative to the fish drying rack – elevation measured at height of GPS antenna. (copy of original photo not yet obtained)


A


B


Ice pile-up at old fish processing plant, on Tagoomanick side of the community


Overwash into Tagoomanick River bend S. of old community site

Notching at base of coastal bluff, old community site

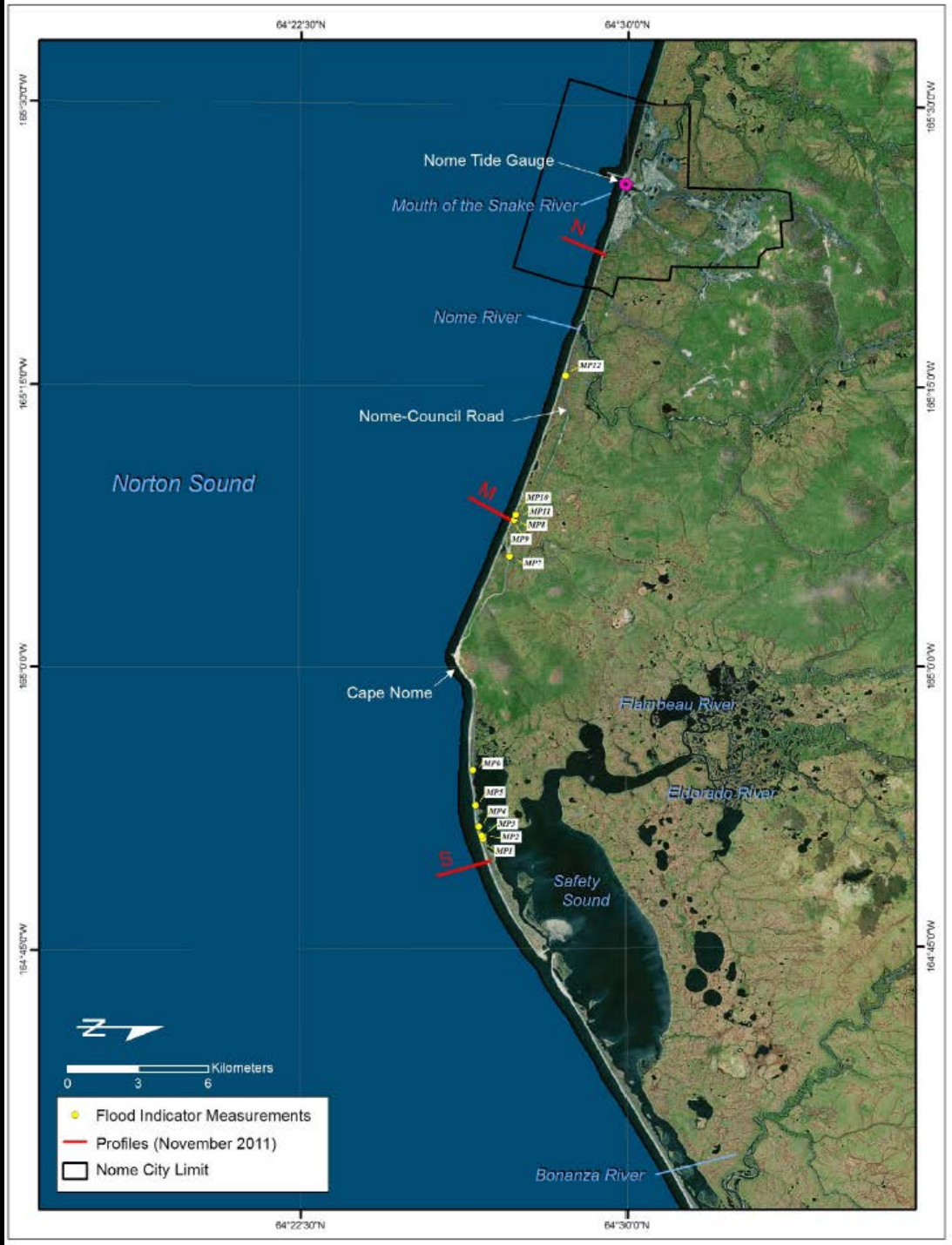
NOME
- SOLOMON

In one day:

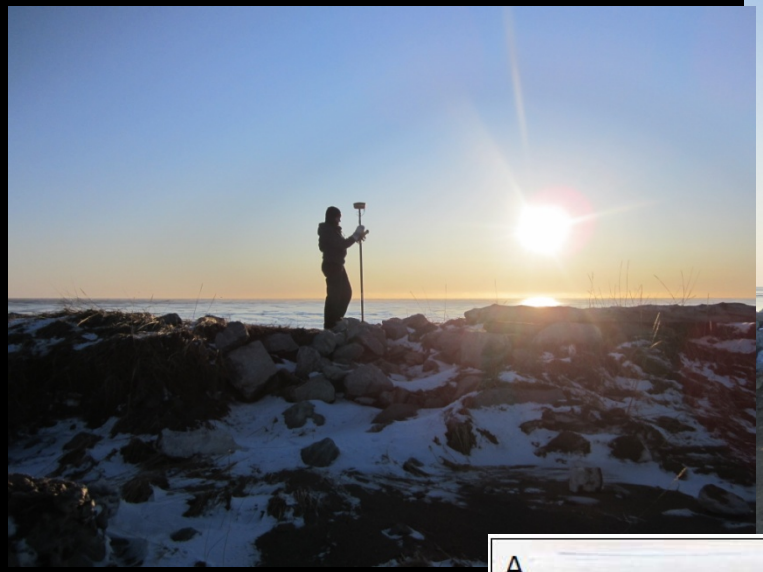
- Established 3 coastal profiles
- Measured ~12 inundation extents

Lots of damage to engineered revetments with large armor rock carried from the ocean side of the road in places into the inland lagoon.

Impressive coastal bluff overtopping ~10 miles east of Nome.



Overtopping, overwash and erosion along road to Solomon




A
B
C

GOLOVIN

In one day:

- Measured 32 inundation extents
- Documented ivu damages
- Collected numerous photos and video recordings

Extensive flooding throughout the lower community and a large ivu (ice push) that carried some cabins ~1 km and piled others up/reduced them to rubble at a fish camp further up in the bay.

Loss of telephone service, high winds.

John Peterson

Flooding in Golovin

Rachel Olson

John Peterson

Mapping the Storm Surge inundation extent in Golovin

ALASKA DIVISION OF GEOLOGICAL &
GEOPHYSICAL SURVEYS

REPORT OF INVESTIGATION 2012-2
Kinsman and DeRaps (2012)
SHEET 1 OF 1

Coastal Flooding in Golovin, Alaska, following the November 2011 Bering Sea Storm

N. Kinsman[1] and M. DeRaps[2]

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Five overview images of Golovin during the flood appear in chronological order to the right →

Lower portion of Golovin
~11:30 am 11/9/11
Photo by Debbie Arungazuk

Lower portion of Golovin
~2:00 pm 11/9/11
Photo by Debbie Arungazuk

Lower portion of Golovin
4:15 pm 11/9/11
Photo by John Peterson

Lower portion of Golovin
4:15 pm 11/9/11
Photo by John Peterson

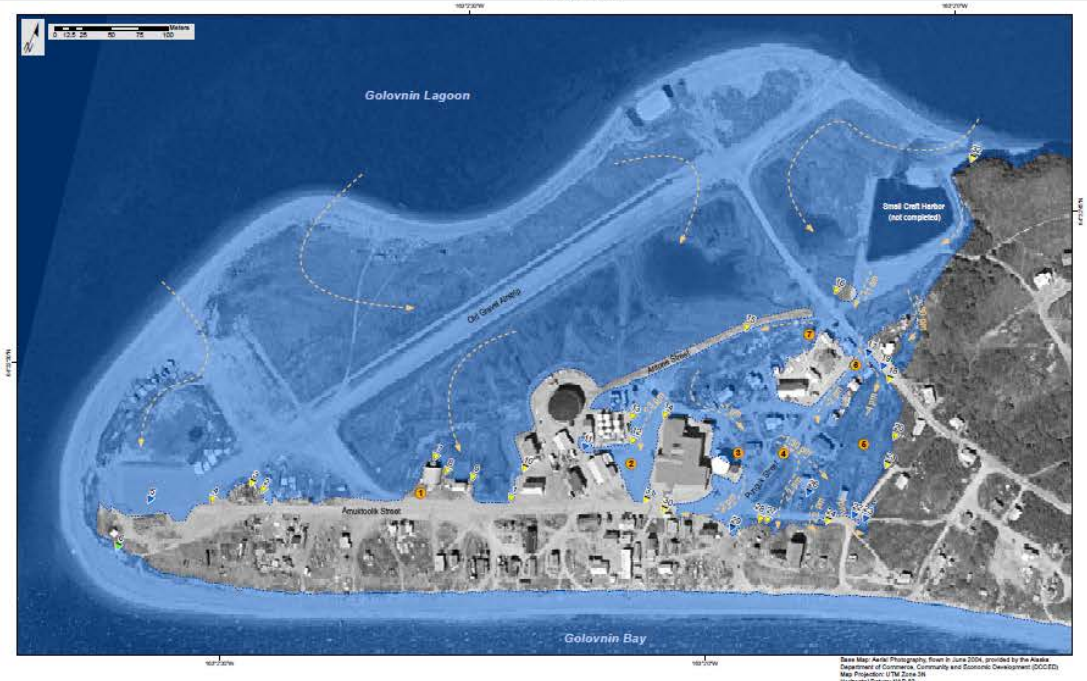
Highest water in front of school
5:00 pm 11/9/11
Photo by Rachel Olson

On November 8, 2011, an extra-tropical cyclone with a low pressure of 945 millibars developed over the Bering Sea and moved northeast across the western coast of Alaska. This severe low-pressure system brought high winds and a large storm surge to the entire Norton Sound region. This storm caused extensive flooding in the lower portion of Golovin on the afternoon of November 9, 2011.

A team of Alaska Division of Geological & Geophysical Surveys (DGGS) scientists visited Golovin on November 15, 2011, to document peak water levels, runup elevations, and inundation extents caused by this event. This map summarizes the extent of the November 9, 2011, flooding and was created from DGGS measurements of flood indicators in combination with elevations on the 2004 Alaska Department of Commerce, Community & Economic Development (DCCED) community map and photographs taken by local residents during the storm. General flow directions are based on eyewitness accounts and a vertical model of static inundation to the elevations presented on the DCCED map. Approximate times of inundation in different parts of the community are based on the timestamps of the photographs that were provided by residents. A draft version of this map was reviewed by community members for accuracy and to resolve gaps in observed inundation extents as well as discrepancies between 2004 DCCED elevations and present-day conditions. The DGGS team would like to extend their deepest gratitude to all of the community members who took the time to share their videos, photographs, and observations and to those who provided the feedback that improved this map.

For additional information on the content of this map and a discussion of the inferred elevation of the storm tide in Golovin, please see the accompanying DGGS report.

Overview Map of Norton Sound



Base Map: Aerial Photography, flown in June 2004, provided by the Alaska Department of Commerce, Community and Economic Development (DCCED)
Map Projection: UTM Zone 3N
Horizontal Datum: NAD 83

Elevations and Descriptions of Flood Indicators Measured in Golovin on November 15, 2011

Point Number	Measurement Type	Confidence level	Elevation in Meters (NAVD88)	Description
GLV_14	Inundation limit	Lowest	3.18 ±0.58	Slush line near the corner of the school (modified)
GLV_18	Inundation limit	Lowest	3.27 ±0.58	Elevation of tension cracking in snow surface near road
GLV_15	Inundation limit	High	3.58 ±0.60	Truncated snow and slush line along paved Antone Street
GLV_13	Inundation limit	High	3.66 ±0.59	Slush line visible on silke surrounding tank farm
GLV_17	Inundated area	High	3.78 ±0.59	Location of overflow across the road to low-lying area
GLV_04	Inundation limit	High	3.93 ±0.66	Slush line near sewer drain field (minor snow cover)
GLV_02	Inundation limit	Lowest	4.02 ±0.58	Transition in slush surface near the old runway
GLV_05	Inundated area	Medium	4.07 ±0.59	Slush-covered area near sewer drain field
GLV_09	Inundation limit	Medium	4.10 ±0.58	Slush line along a berm that was raised up in 2008
GLV_26	Inundated area	High	4.02 ±0.66	Area by homes that were surrounded with water
GLV_01	Inundation limit	Medium	4.12 ±0.58	Slush line along road near generators; ice present
GLV_11	Inundated area	Medium	4.11 ±0.61	Slush-covered area by water holding tank (modified)
GLV_23	Inundated area	Medium	4.16 ±0.57	Low-lying portion of road that was flooded (modified)
GLV_27	Inundation limit	Lowest	4.19 ±0.57	Slush line along the road near Dexter Roadhouse
GLV_20	Inundation limit	Lowest	4.20 ±0.57	Slush line along hillside edge of a low-lying area
GLV_12	Inundation limit	Medium	4.22 ±0.58	Slush line between school and the tank farm
GLV_24	Inundation limit	Lowest	4.27 ±0.58	Elevation of tension cracking in snow surface along road side, exact slush limit obscured by road clearing
GLV_19	Inundated area	Medium	4.32 ±0.58	Location of overflow across road into low-lying area
GLV_16	Peak flood level	High	4.32 ±0.60	Water level as preserved on the sides of a soil fill pile between Antone Street and the small craft harbor fence
GLV_28	Inundation limit	Medium	4.42 ±0.58	Slush line on a mound near road at Dexter Roadhouse
GLV_07	Inundation limit	Medium	4.46 ±0.58	Slush line on side of earth foundation below hangar
GLV_06	Inundation limit	High	4.44 ±0.60	Elevation of tension cracking in snow surface
GLV_21	Inundation limit	Medium	4.49 ±0.57	Slush line along hillside edge of a low-lying area
GLV_03	Inundation limit	Lowest	4.56 ±0.58	Transition in slush surface near the old runway
GLV_22	Inundated area	Lowest	4.66 ±0.60	Location of overflow forming a pool across the road
GLV_30	Inundation limit	Lowest	4.80 ±0.58	limit of floodwater on road in front of school, as determined by an in situ consensus of residents
GLV_10	Inundation limit	High	4.83 ±0.58	Slush line between the washeteria and the power plant
GLV_31	Inundation limit	Lowest	4.99 ±0.58	limit of floodwater on road in front of school, as determined by an in situ consensus of residents
GLV_29	Inundated area	Lowest	5.30 ±0.58	Slush-covered area on road by church (modified)
GLV_08	Overtopped area	High	5.29 ±0.60	Crest elevation of ice ridge overtopped by waves (frozen puddle behind) at south tip of community
GLV_32	Peak flood level	High	5.59 ±0.59	Water level as observed in a truncated snowdrift on the cliffs on the north side of community

This work is funded with qualified outer continental shelf oil and gas revenues by the Coastal Impact Assistance Program, U.S. Fish and Wildlife Service, U.S. Department of the Interior. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government.

1
Back side of Alaska State Senator Donnie Olson's hangar, looking northwest
~ 2 pm 11/9/11
Photo by John Peterson

2
Between the school entrance and the tank farm, looking north
~ 4 pm 11/9/11
Photo by Clara Neyokpuk

3
Blue house near the school, looking southwest
3:30 pm 11/9/11
Photo by John Peterson

4
Spilling overflow at road, looking northwest
2:30 pm 11/9/11
Photo by John Peterson

7
Flooded communication towers, looking west
4:30 pm 11/9/11
Photo by Rachel Olson

5
Overtopped portion of road, looking west
4:30 pm 11/9/11
Photo by Rachel Olson

6
Low area looking south towards Dexter Roadhouse
4:30 pm 11/9/11
Photo by Rachel Olson

Map Symbols

- Flood Extent
- Measured Observations (point location is at base of triangle)
- Flow Direction and approximate time (11/9/2011)
- Inundated Area
- Inundation Limit
- Photo Locations
- Overtopped Area

Note: Golovnin Bay or Golovnin Lagoon are alternatively Golovin Bay or Golovin Lagoon. The original Russian spelling (Golovnin) is used on most published maps and charts.

State of Alaska
Department of Natural Resources
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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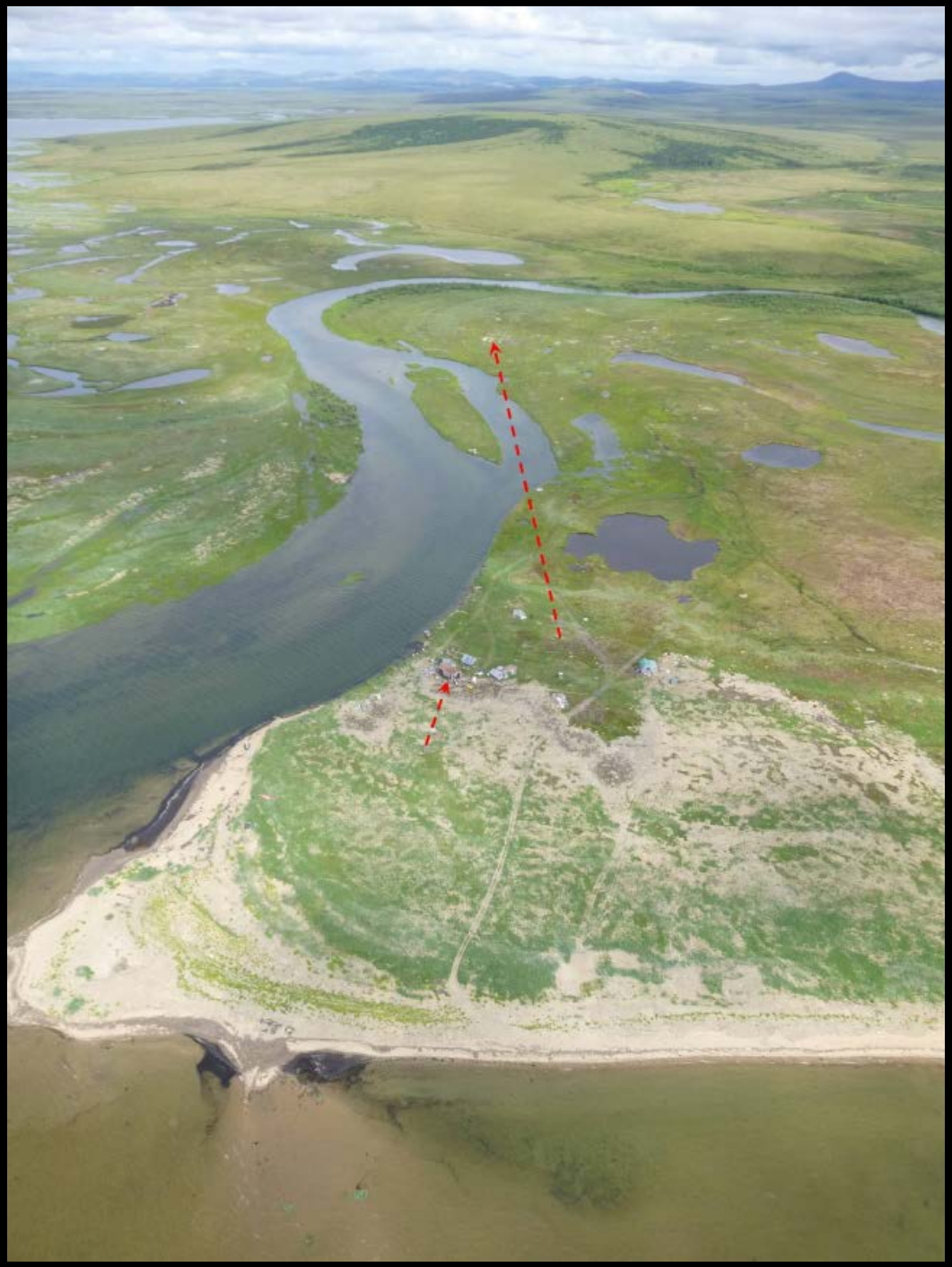
Ivu at Golovin Fish Camp

Toby Anungazuk

Toby Anungazuk

Ivu at Golovin Fish Camp

Revisited Ivu site in July 2012



CONCLUSIONS

NWS did a good job forecasting surge heights for this event

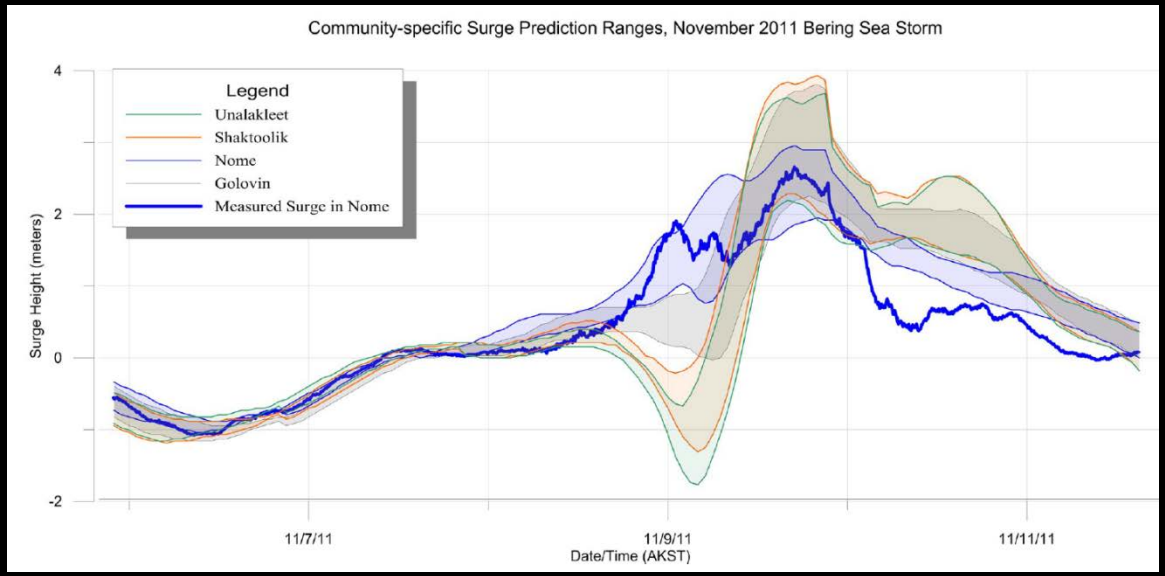
Community preparedness reduced damages and deaths

Storm surge = ~ 3 meters

Total water level = ~ 4 meters

Wave runup heights vary along coastlines and were observed to be up to 4.4 m higher than forecasted surges

Nearshore ice and offshore winds played a big role in reducing wave energy during this storm



Water Level Type	Vertical Datum	Unalakleet	Shaktoolik	Nome	Golovin
Storm Tide Level (surge + tide)	Local MSL	2.7 m	3.3 m	3.3 m	no tidal datum
	NAVD88 (GEOID09)	4.1 m	4.7 m	4.4 m	4.3 ±0.6 m
TWL, Total Water Level (surge + tide + setup)	Local MSL	4.2 m	–	4.2 m	no tidal datum
	NAVD88 (GEOID09)	5.7 m	–	5.3 m	5.6 ±0.6 m
Water Level Component					
Mean Tidal Range		0.97 m	0.74 m	0.31 m	<0.55 m
Storm Surge Height (Storm tide level – predicted tide)		–	–	3.2 m	–
Wave Setup Height (Storm tide level – TWL)		+1.6 m	–	+0.9 m	+1.3 m
Maximum Runup in Community (height above storm tide level)		+3.1 m	+2.3 m	–	–
Maximum Runup (height above storm tide level)		+3.5 m	+4.4 m	+3.1 m	–

What we learned from the rapid-response:

- Residents are more able to provide logistical support in winter
- People are more forthcoming with photos/video right after event
- Extremely useful to see coastline conditions in storm season

DGGS is committed to conducting similar operations in the event of future large storm surge events

Report of Investigations 2012-2
Version 1.1

COASTAL HAZARD FIELD INVESTIGATIONS IN RESPONSE TO THE NOVEMBER 2011 BERING SEA STORM, NORTON SOUND, ALASKA

by
Nicole E.M. Kinsman and Meagan R. DeRaps

Published by

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DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

2012

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Thank You