Establishment of Continuous Tidal Datums Using Spatial Interpolation

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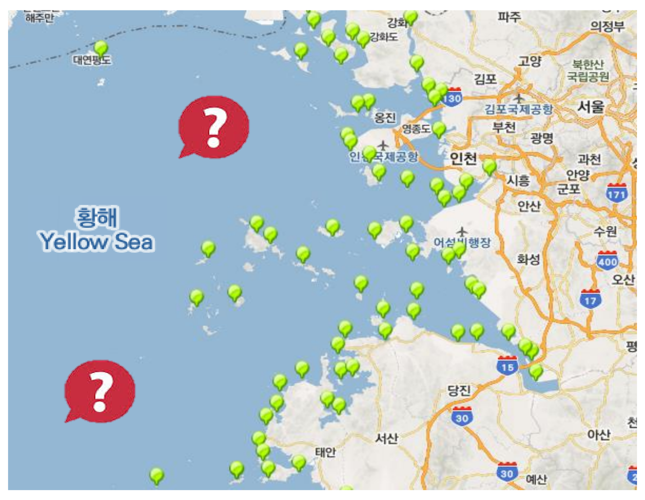
1. Background and Purpose

- **Tidal Bench Marks are displayed in dots and laid only under tidal observation areas**



· Height differences of tidal datums in each local areas

· Getting the height information of a certain location without tidal bench mark

· Getting the height information by using GNSS without tidal observation

- **Global trend of hydrography standard unification in an ellipsoid**

· USA(V-Datum), UK(VORF): establishment of conversion system between tidal datum system and the ellipsoid.

· 2014 FIG publication No. 62: ellipsoid of tidal datums as official standard.

· 2016, IHO recommends to use the ellipsoid for observation standard of tidal and sea level.

Establishment of tidal datums in ellipsoid standard by using spatial interpolation

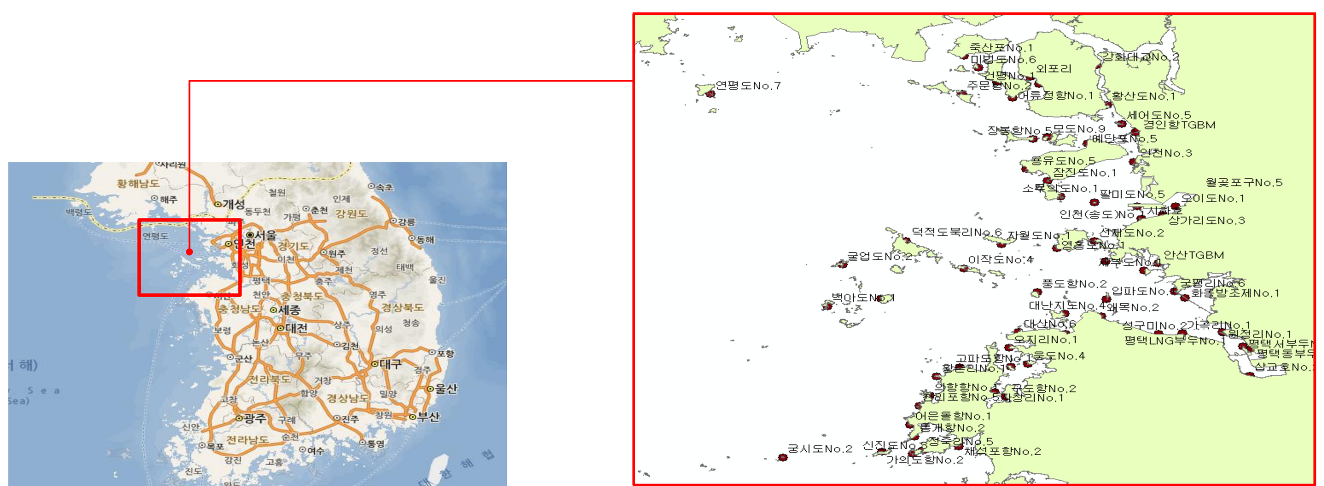
2. Method

- **Study area is Gyeong-gi bay in Yellow Sea, Korea**

· The Republic of Korea is surrounded by the sea on three sides of the country.

· Due to the nature of the Yellow Sea, there is a large difference in tidal tide, the coastline is complicated, and the characteristics of ocean currents are various.

· Therefore, if the optimal spatial interpolation method is derived from the west coast region, it could be applied to all the waters of Korea.



<Dispersion of tidal bench marks>

Figure 1. Experiment target area

- **For spatial interpolation, Spline with Barrier with Idw, Kriging, Spline, Spline with Barrier(Minimum Curvature techniques) was selected.**
- **For experiment data, using the 67 baseline points acquired in 2016, we extracted the height values from the ellipsoidal surface to the regional mean sea level.**

3. Experiment

• Experiment of Parameter Selection

· Repetition of cross validation that compares observed and expected values by using 67 tidal bench marks and excluding 1 each time

〈IDW〉 Unit : cm

Power	RMSE
1	20.1379911
1.5	18.1539135
2	14.9404941
2.5	13.5309015
3	12.2002601
3.5	12.2959557
4	12.3266125

〈Spline〉 Unit : cm

Parameter		RMSE
Regularized	0.1	20.137991
	0.2	14.940494
	0.3	12.200260
	0.4	12.026612
Tension	0.1	24.724587
	0.2	18.153913
	0.3	13.530901
	0.4	12.295955

〈Kriging〉 Unit : cm

Parameter		RMSE
Ordinary	Spherical	9.7521530
	Circular	9.9383077
	Exponential	9.7523364
	Gaussian	10.0696171
	Linear	9.99108649
Universal	Linear with Linear drift	9.71221950
	Linear with Quadratic drift	12.1202543

〈Spline with Barrier〉 Unit : cm

Smoothing factor	RMSE
0.6	9.9445871
0.7	9.9104942
0.8	9.8945875
0.9	9.8050205
1.0	9.9023729

• Spatial interpolation experiment and comparative validation

· Comparison between observed values after spatial interpolation

· Excludes external verification results(7) among 67 tide bench marks

※ External verification : verifies accuracy with unutilized points when modeling

- **Spatial interpolation experiment and comparative validation with observed value**

· Comparison between observed values after spatial interpolation using 67 tidal bench marks

- **Results of Spatial Interpolation Experiment**

· Minimum standard for hydrographic survey of IHO regulation is 25cm

· All fit except IDW interpolation

· Spline with Barrier is the best fit which can interpolate considering coast lines

Unit : cm

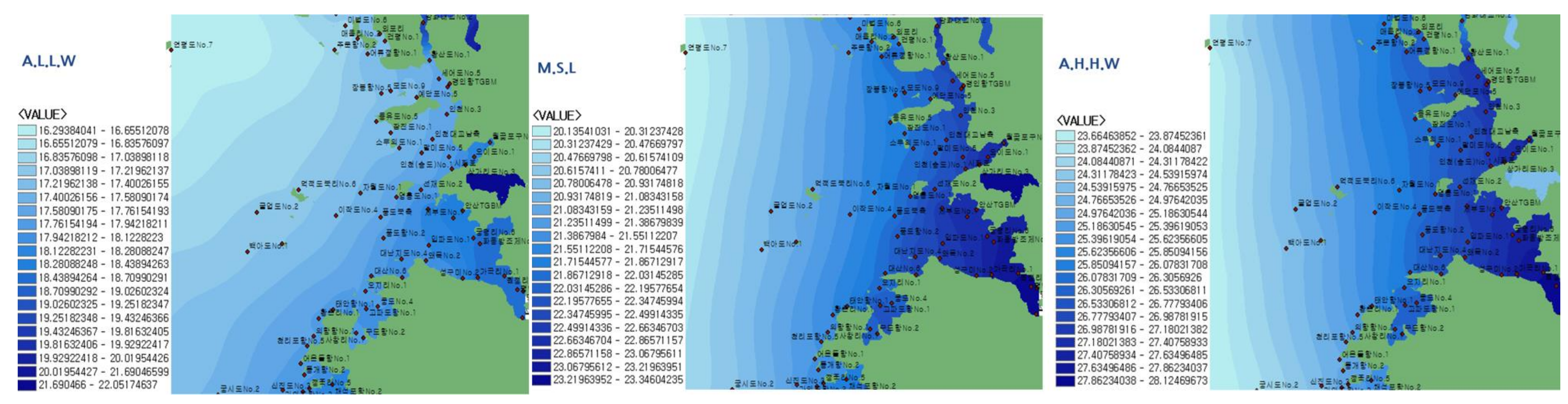
Point	IDW	Kriging	Spline	Spline with Barrier
Deokjeokdo bukri	-15.19	0.89	0.76	-3.78
Jumun hang	-28.11	17.60	-19.02	-19.63
Incheon hang	-0.86	-4.74	0.29	-1.56
Palmido	-1.73	-7.68	5.47	-0.83
Pungdo hang	18.95	8.71	15.37	6.75
Gungpyeong hang	-10.32	0.89	-3.48	-4.58
Eoeundol hang	-8.03	-2.22	0.43	1.52
North of Pungdo	12.84	-9.48	12.41	-12.51
South of Incheon Grand bridge	-13.17	-9.23	3.51	-6.12
RMSE	14.503	8.490	9.470	8.599

Figure 2. Result of each interpolation

- **Construction of Tidal Datums (with Tidebed System)**

· Information database of tidal features(harmonic constants, nonharmonic constants) and datum level in sea grids

· Computation of semirange sum of four largeness tide value(Z0) of experiment area



※ M.S.L – Semirange sum of four largeness tide value = A.L.L.W

※ M.S.L + Semirange sum of four largeness tide value = A.H.H.W

Unit : m

	Observed value (A.L.L.W)	Forecasted Value (A.L.L.W)	Observed Value (A.H.H.W)	Forecasted value (A.H.H.W)
Gungpyeong hang	18.3842	18.3992	27.3982	27.4054
Deokjeokdo bukri	17.0583	17.1125	25.3063	25.2649
Eoeundol hang	17.8332	17.8283	24.9592	24.9691
Incheon hang	17.7835	17.7147	27.0535	27.1265
Jumun hang	16.8761	16.8872	25.7861	25.7802
Palmido	17.6079	17.6136	26.6859	26.6905
Pungdo hang	17.8375	17.8493	26.4395	26.4404
North of Pungdo	17.5720	17.6211	26.8000	26.7631
South of Incheon Grand bridge	17.6430	17.6188	26.1310	26.1594
RMSE		0.03529		0.03235

Figure 3. Observed value and forecasted one by each tidal datum

4. Conclusion

· Proper parameter selection is needed since the expected results vary depending on parameter

· Spline with Barrier(Minimum curvature) is considered as the best spatial interpolation

· Spatial interpolation can be performed considering the Special Reference of minimum standard for hydrographic surveys of IHO and coast-lines

· Height information is achievable through GNSS survey without tidal observation

▪ Acknowledgements

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