Brief explanation on the regional characteristics of Sanriku Coast

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Regional outline of Sanriku Coast where coastal settlements had catastrophic destruction by the tsunami is presented, including its location, history, main local industries, tsunami damage, and prospects for the recovery.

1. Introduction

As presented in the beginning two chapters reported by the author, Sanriku Coast is the most severely damaged region by the East Japan Earthquake and Tsunami on March 11, 2011. The most part of the coast was hit by huge tsunami with the height of 10m or more at the shoreline, and was inundated up to 3 km from the shore in the most intensive cases\(^1\). Such severe natural phenomena caused heavy damages beyond any expectations.

The name of “Sanriku” originally means three ancient regions of Rikuzen (mainly Miyagi Prefecture), Rikuchu (mainly Iwate Prefecture), and Mutsu (mainly Aomori Prefecture), all of which contain “rika (陸)” in their Japanese character. But now “Sanriku” is used identical to “Sanriku Coast”. It was owing to former catastrophic phenomena occurred in more than a hundred years ago.

2. Physical setting and tsunami disaster

Generally called Sanriku Coast is the coastal area along the Pacific shore with rugged and indented coastline mainly from Hachinohe to Ishinomaki in northeastern Honshu (Fig.1). It is well-known as a typical “Rias” type of coastline in Japan’s school education. Such shape of coast finds usually the adequate place for the harbor with deep bay and calm wave. Actually many of people inhabited there depending mainly
on seaports which enable to utilize the marine resources from their frontal sea. And it was fortunate for the people to have a lot of benefit from the sea where warm current (Kuroshio) and cold current (Japan Stream) meets brings rich marine fishery resources.

As is usually the case for the Rias type of coast including Sanriku, hilly landform with limited flatlands can only allow the settlements to locate near shore often in the bottom of narrow bays. Tsunami wave easily rise bigger in such bays, and shoreline settlements can be easily affected by it. Unfortunately, Sanriku Coast lies parallel to the Japan Deep where the Pacific Plate moving beneath the Japan Archipelago which causes cyclical but virtually sudden thrust of micro plates triggering huge tsunami. After the Meiji Restoration, Sanriku Coast suffered from severe tsunami damages in 1896 and 1933. The name of “Sanriku” became well known firstly in modern Japan by the newly established newspapers reporting severe tsunami damage in the coastal area of Sanriku region in 1896. It was generally believed as a reason “Sanriku” became in use for the same meaning of “Sanriku Coast”. Even in pre-modern age, archive documents told some big tsunamis gave damages to coastal area in Sanriku, among which the events happened in 869 and 1611 were significant ones followed huge damages.

3. History of local economy

Sanriku Coast was known historically as a shipping area of such special products as dried abalone, sea cucumber and shark fin, which were shipped to Yedo (ancient name of Tokyo) and some of them were exported to China. In the period of Japan’s industrial revolution mainly in 1910-1920’s, advanced fishing boats and methods developed manly in Europe were introduced to this area, by which some towns in the harbors grew up to the base ports for off-shore fishing. Hachinohe, Miyako, Kesennuma , Onagawa and Isinomaki shown in Fig.1 are such base ports. During the period of Japan’s High Economic Growth in 1960-70’s, these fishing ports rapidly grew up as the bases for far-sea fisheries including tuna long-lining, salmon drift net, and trawl net in the northern Pacific or other seas in the world. In addition, technologies of aquaculture for “wakame” seaweed, laver, and oyster were developed in inshore bays or inlets mainly after 1950’s.

After the latter half of 1970’s, when the Oil crisis came and the exclusive economic zone was introduced in Japan and some of its adjacent countries, the far-sea fishery began to decline, resulting the long-term reduction of fishery catches in major fishing ports in Sanriku (Fig.2). Worldwide factors such as the exhaustion of fish resources by over exploitation and the so-called “Regime Shift” in the environment system are another causes of such change in marine resources.
4. Population

Because of above mentioned regional background, population in Sanriku Coast concentrated in some towns or cities which have major fishing ports, and population density is totally lower in comparison with the inland area (Fig.3). Since 1970's, the population turned to decrease owing mainly to the reduction of far-sea fishery. Population of the most of municipalities in Sanriku coast decreased from 1970 to 2000, while it increased in 8.7% totally in Tohoku Region. The most depopulated was Oshika (now a part of Ishinomaki City) with -50.1%.

At the same time, aging of population has advanced. Ratio of the population with 65 years old and over surpassed the Tohoku’s average of 20.3% in most of municipalities; the highest is 33.4% again in Oshika.
5. Fishery and related industries

In spite of the long term reduction, local economy of Sanriku Coast inevitably depends largely on fishery and its related industry, because of limited agricultural production owing to narrow flat lands and frequently appearing cold summer. In addition, the remote location from the arterial transportation lines of Tohoku Expressway and Shinkansen became unfavorable regional factor for the development of other industries than fishery even during the Japan’s rapid economic growth. By such background, fishery in Sanriku Coast keeps a status of the major local industry, and Sanriku is still one of Japan’s major fishery regions seated some major fishing ports (Fig.4).

Table 1  Sanriku’s share in Japan for main fishery resources

<table>
<thead>
<tr>
<th></th>
<th>Aomori *</th>
<th>Iwate</th>
<th>Miyagi</th>
<th>sub total</th>
<th>share in Japan(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>fishing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuna</td>
<td>3,532</td>
<td>6,684</td>
<td>29,636</td>
<td>39,852</td>
<td>16.7</td>
</tr>
<tr>
<td>south tuna</td>
<td>63</td>
<td>310</td>
<td>1,724</td>
<td>2,097</td>
<td>34.3</td>
</tr>
<tr>
<td>marlin</td>
<td>340</td>
<td>712</td>
<td>5,064</td>
<td>6,116</td>
<td>31.6</td>
</tr>
<tr>
<td>shark</td>
<td>1,012</td>
<td>2,351</td>
<td>23,735</td>
<td>27,098</td>
<td>75.2</td>
</tr>
<tr>
<td>saury</td>
<td>4,054</td>
<td>15,765</td>
<td>32,230</td>
<td>52,049</td>
<td>22.2</td>
</tr>
<tr>
<td>cod</td>
<td>1,966</td>
<td>9,105</td>
<td>12,236</td>
<td>23,307</td>
<td>47.5</td>
</tr>
<tr>
<td>red fish</td>
<td>60</td>
<td>9</td>
<td>535</td>
<td>604</td>
<td>81.7</td>
</tr>
<tr>
<td>rock fish</td>
<td>333</td>
<td>71</td>
<td>302</td>
<td>706</td>
<td>49.5</td>
</tr>
<tr>
<td>krill</td>
<td>20,677</td>
<td>20,287</td>
<td>40,964</td>
<td>49.0</td>
<td>89.0</td>
</tr>
<tr>
<td>abalone</td>
<td>34</td>
<td>231</td>
<td>156</td>
<td>421</td>
<td>23.8</td>
</tr>
<tr>
<td>squid</td>
<td>81,685</td>
<td>19,626</td>
<td>14,241</td>
<td>115,552</td>
<td>35.0</td>
</tr>
<tr>
<td>urchin</td>
<td>836</td>
<td>1,524</td>
<td>894</td>
<td>3,254</td>
<td>27.1</td>
</tr>
<tr>
<td>aquaculture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silver salmon</td>
<td>9,174</td>
<td>9,174</td>
<td>99.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>oyster</td>
<td>12,337</td>
<td>56,669</td>
<td>69,006</td>
<td>30.7</td>
<td></td>
</tr>
<tr>
<td>ascidian</td>
<td>1,828</td>
<td>10,079</td>
<td>11,907</td>
<td>95.4</td>
<td></td>
</tr>
<tr>
<td>kelp</td>
<td>399</td>
<td>12,804</td>
<td>2,163</td>
<td>16,366</td>
<td>30.1</td>
</tr>
<tr>
<td>wakame</td>
<td>13</td>
<td>24,704</td>
<td>18,743</td>
<td>43,460</td>
<td>72.6</td>
</tr>
<tr>
<td>Total Catch</td>
<td>140,465</td>
<td>145,101</td>
<td>278,691</td>
<td>564,257</td>
<td>12.7</td>
</tr>
</tbody>
</table>

*: Pacific coast  Source : Annual report for fishery and aquaculture (2005)
Table 1 shows how Sanriku Coast plays an important role in Japan’s fishery, where we can grasp that many of Sanriku’s fishery resources have significant shares in the national total. In addition, major fishing ports have fishery related industries to distribute the unloaded resources to other region, to process them, to repair fishing boats, and to support the preparation for the next leave. Table 2 shows some of such functions estimated using the national censuses. Actually, more other fishery related industries are usually located in fishing ports, including various types of service for the fishing, shipping, fishermen, and administrative services. We should recognize the major fishing ports in Sanriku hosted functional complexes of such fishery and its related industries.

Table 2  Fishery related industries in major ports in Sanriku

<table>
<thead>
<tr>
<th></th>
<th>Seafood processing</th>
<th>Cold storage</th>
<th>Ice making</th>
<th>Ship building and repair</th>
<th>Wholesaling for fish and shellfish</th>
<th>Retailing for fish and shellfish</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>factory worker</td>
<td>cold storage</td>
<td>ice making</td>
<td>ship building and repair</td>
<td>wholesaling for fish and shellfish</td>
<td>retailing for fish and shellfish</td>
<td>Total</td>
</tr>
<tr>
<td>Hachinohe</td>
<td>88</td>
<td>89,3,647</td>
<td>5</td>
<td>45</td>
<td>18</td>
<td>414</td>
<td>69</td>
</tr>
<tr>
<td>Miyako</td>
<td>48</td>
<td>1,206</td>
<td>52</td>
<td>1,114</td>
<td>3</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>Kamaishi</td>
<td>16</td>
<td>401</td>
<td>18</td>
<td>493</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Ofunato</td>
<td>31</td>
<td>1,202</td>
<td>33</td>
<td>1,162</td>
<td>0</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Kesennuma</td>
<td>96</td>
<td>3,417</td>
<td>64</td>
<td>3,009</td>
<td>4</td>
<td>53</td>
<td>26</td>
</tr>
<tr>
<td>Ongawa</td>
<td>32</td>
<td>1,199</td>
<td>25</td>
<td>1,106</td>
<td>3</td>
<td>49</td>
<td>1</td>
</tr>
<tr>
<td>Ishinomaki</td>
<td>115</td>
<td>3,868</td>
<td>83</td>
<td>3,188</td>
<td>5</td>
<td>36</td>
<td>33</td>
</tr>
<tr>
<td><strong>Sub Total</strong></td>
<td><strong>426</strong></td>
<td><strong>364</strong></td>
<td><strong>21</strong></td>
<td><strong>103</strong></td>
<td><strong>403</strong></td>
<td><strong>205</strong></td>
<td><strong>205</strong></td>
</tr>
<tr>
<td><strong>Sanriku Total</strong></td>
<td><strong>526</strong></td>
<td><strong>439</strong></td>
<td><strong>25</strong></td>
<td><strong>128</strong></td>
<td><strong>1,395</strong></td>
<td><strong>212</strong></td>
<td><strong>1,395</strong></td>
</tr>
</tbody>
</table>


6. Damages

As shown in the previous chapters and as informed widely by the TV or internet, damages caused by the East Japan Earthquake and Tsunami in Sainriku Coast was catastrophic. In this section, brief outline of the damages will be reviewed.

1) Human and housing

Fig.5 shows human damages by municipality. The highest ratio of dead and lost people to the population is Otsuchi (9.48%), and the next three are Onagawa (9.44%), Rikuzentakata (9.08%), Minami-Sanriku (5.66%). All of these are located at the bottom of narrow bays in Sanriku Coast. The municipality with the worst number of human damages (3,153 dead and 890 lost) is Ishinomaki City, where not only many of fishing villages but also the densely populated urban area were flooded away by up to 10m-high tsunami.

Fig.6 shows the number of completely and half-destroyed houses. The intensity of earthquake was so severe and wide this time, the large number of damaged houses appear not only in tsunami affected coastal area, but also in inland area such as Koriyama City and suburban Sendai. But the
ratio of “completely” destroyed houses are high especially in the coastal region suffered from severe damage of tsunami.

2) Damages for fishery

Among all industries in tsunami affected regions, fishery and relating marine product industries got the most devastating damages. Table 3 and 4 show that the fishery and relating facilities in the three prefectures were almost completely destroyed. Especially, Iwate and Miyagi, which are located in Sanriku Coast, are (or “were”) one of the most thriving fishery areas in Japan. Most of the fishing ports in this area lost almost all facilities relating to fishery and marine products.

As for marine products processing factories shown in Table 4, about 80% of factories were destroyed in Iwate and Miyagi, because most of such factories were located near fishing port and destroyed or flooded away by tsunami.
3) Damages for manufacturing factories

Not only the fishery and related industries, but also any industries in tsunami affected area assumed to suffer severe damages. Table 5 shows the manufacturing factories located in tsunami affected area in three prefectures. More than one thousand factories in total were located there. Among three prefectures, Miyagi assumed to have the most severe damage, of which ratio to all factories reach 16.4% in number of factories, and 14.4% in workers, and 21.9% in output value. In Miyagi prefecture, many of factories were located in the industrial estates developed near port areas, such as the case of marine product factories’ estates in Kesennuma, Ishinomaki and Shiogama, Sendai Port industrial park, and Sendai Airport industrial estate.
Table 5  Damages for manufacturing factories in tsunami affected area

<table>
<thead>
<tr>
<th></th>
<th>number of factories in tsunami</th>
<th>ratio(%) to all factories</th>
<th>number of workers in tsunami area</th>
<th>ratio(%) to all factories</th>
<th>output value (billion yen) in tsunami area</th>
<th>ratio(%) to all factories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iwate</td>
<td>164</td>
<td>4.2</td>
<td>3,592</td>
<td>3.6</td>
<td>7,440</td>
<td>2.9</td>
</tr>
<tr>
<td>Miyagi</td>
<td>850</td>
<td>16.4</td>
<td>18,430</td>
<td>14.4</td>
<td>77,960</td>
<td>21.9</td>
</tr>
<tr>
<td>Fukushima</td>
<td>77</td>
<td>1.0</td>
<td>1,692</td>
<td>0.9</td>
<td>5,910</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Ministry of Economy, Trade and Industry (http://www.meti.go.jp/statistics)

7. Reconstruction

Every damaged municipalities in Sanriku Coast published each redevelopment plan by the end of 2011. Each of them basically contains three major tasks; reconstruction of whole infrastructure, recovery of local business and industries, and creation of disaster preventive community. But there has appeared many difficulties. A case of Onagawa Town will be presented here.

Onagawa Town of which registered population was 12,000 in 2010 located at the south of Sanriku Coast (Fig.1). Struck by the huge tsunami with the height of 17-23m above sea level, almost entire part of its central part and main port, which faced at the bottom of a narrow bay, was destroyed and flooded away (Fig.7). 541 people which is rated 5.4 % of the total population died or lost, and about 4,300 houses and buildings were destroyed. Not only the central area, but also many of the fishery villages were severely destroyed.

Fig.7  Tsunami affected area (bold line) with tsunami height (m)

affected area : Geographical Information Authority, tsunami height: Tsunami Control Center of Tohoku University
Town’s redevelopment plan was published on September, 2011, containing much of projects to create whole town as shown in Table 6.

Table 6 Projects for recovery and redevelopment

<table>
<thead>
<tr>
<th>Category</th>
<th>Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disaster prevention</td>
<td>Creation of safe and secure port town</td>
</tr>
<tr>
<td></td>
<td>1 rehabilitation of infrastructure in port area</td>
</tr>
<tr>
<td></td>
<td>2 remaking for evacuation plan from the tsunami</td>
</tr>
<tr>
<td></td>
<td>3 centralization of the facilities for disaster prevention</td>
</tr>
<tr>
<td></td>
<td>4 enhancing the function of the public facilities as shelters</td>
</tr>
<tr>
<td></td>
<td>5 remaking the roads’ network for preventing the disasters</td>
</tr>
<tr>
<td></td>
<td>6 creating the self-helping energy system</td>
</tr>
<tr>
<td></td>
<td>7 promoting the community power against the disasters</td>
</tr>
<tr>
<td></td>
<td>8 preservation for the relicts of the tsunami</td>
</tr>
<tr>
<td></td>
<td>9 remaking the regional plan for disaster prevention</td>
</tr>
<tr>
<td>Industries</td>
<td>Regeneration and redevelopment of the port town industries</td>
</tr>
<tr>
<td></td>
<td>1 first aid rehabilitation and early restart of the fishery</td>
</tr>
<tr>
<td></td>
<td>2 redevelopment for the port function and the fishery</td>
</tr>
<tr>
<td></td>
<td>3 rehabilitation for the commercial and manufacturing industries</td>
</tr>
<tr>
<td></td>
<td>4 creation for new employment</td>
</tr>
<tr>
<td></td>
<td>5 rehabilitation and creation for the tourism</td>
</tr>
<tr>
<td></td>
<td>6 creation of the research center for marine science and technologies</td>
</tr>
<tr>
<td>Living environments</td>
<td>Creation of high quality of life</td>
</tr>
<tr>
<td></td>
<td>1 urgent construction for the temporary housing</td>
</tr>
<tr>
<td></td>
<td>2 creation for the safe residential area in the town center</td>
</tr>
<tr>
<td></td>
<td>3 creation for the safe residential area for the villages</td>
</tr>
<tr>
<td></td>
<td>4 provision for the permanent housing</td>
</tr>
<tr>
<td></td>
<td>5 restart and maintenance for the public transportation</td>
</tr>
<tr>
<td></td>
<td>6 promoting the health and life time sports</td>
</tr>
<tr>
<td></td>
<td>7 restoration of the historic sites and traditional cultures</td>
</tr>
<tr>
<td></td>
<td>8 promoting the healthy town both mentally and physically</td>
</tr>
</tbody>
</table>

They were supposed to be accomplished by 2018, which was divided three periods below;

i) period of urgent recovery (2011～12) : provision of temporary shelters, land designation for the planning, reopen of main port and fish market, restart of aquaculture, construction of temporary shops and factories etc.

ii) period of construction for infrastructure (2013～15) : development of new town center and residential estates, ground raising of main port and downtown area etc.

iii) period of completion of redevelopment (2016～18) : completion of new residential area, permanent shops and factories, and all projects to create new Onagawa

Image map of a reborn town center is telling us a hopeful future of Onagawa Town (Fig. 8)
8. Difficulties and prospects

Difficulties to realize the plan would be many. At first, how the agreement among various landowners and inhabitants can be achieved, after deciding to abandon their home places and to move new places. In the second, how the huge cost can be raised in order for the people to pay from their own limited properties. The third and most urgent difficulty is to provide the employment opportunities for the people who lost all their living fundamentals. Without any earnings, it would be unavoidable for the people to move out of the town before the projects can be achieved. Though the fishery activities which was main local industry in the town partly resumed by the end of 2011 (Table 6), it is far limited in comparison with the before.

Every damaged towns and cities share such situation and difficulties. The author believes that long-term supports and concerns for the region would be necessary until every community can finally recover and create alternative living culture enough defensive against cyclically coming tsunami disaster.