THE SOCIETY EMPOWERMENT OF TANAH DATAR DISTRICT AT SINGKARAK LACUSTRINE AREAS USING THE INTEGRATED FARMING SYSTEM, AGROFORESTRY AND AGROECOTOURSM

Azwar Rasyidin, Gusmini, Amrizal Saidi, Erigas Eka Putra, Hermansah, Irzal, Firmansyah, Yenni, Ellihasridas, Masrizal, Refdinal, Fashbir dan Sri Wahyuni

Universitas Andalas
rasyidin.azwar@yahoo.co.id

Abstracts

The program for society empowerment (Sibermas) has done at sub districts of Batipuh Selatan district of Tanah Datar were conducted three kenagarians (traditional village) ie, Guguak Malalo, Padang Laweh and Batu Taba. This program was intended to promote regional resources under university guidance. Singkarak drainage basin has known as the degraded land of West Sumatra, which parts of area conducted to District Solok and another are under district of Tanah Datar. Rainfall recorded shows that annual precipitation is less than 2000mm in the ranges 1600-.1850mm annually. However the mountaneous areas in the western part are wetter than the eastern parts. Due too the program were divided as for western part as sustainable village energy development by constructed micro hydro electric power and bio energy, and in the eastern parts which planted more bio fuel such as jatropacurcas and other plant such as pecan trees or cacao. Base on hydrological condition western part are possible do develop rice intensification combine with fish or fish pond. For this purpose Andalas University team promote all off activities and give guidance and technical assistance for those activities. Finally the region will promote as the ecotourism areas of West Sumatra

Key word, Agroforestry, Agrotourism, integrated farming, land degradation, society empowerment

.

Introduction

Singkarak drainage basin is the inland areas of the Indragiri catchment, this river flow from the Barisan range up to eastern coast of Sumatra at the Riau provinve. The areas was known as the degraded land of West Sumatra province. Singkarak and surrounding areas has agroclimatic zone D and E which lower annual precipitation and 3 or 4 consecutive dry month. Usually the month which deficit water is May, June, July and August, some time the water deficit also observed at February. Natural vegetation as the land cover are extremely poor. The western parts as the grouping for Sumani watershed which divided to 7 subwatershed covered by forested areas less than 23% from the total areas 59300 ha or 13536 ha is forest. The eastern parts almost no forest, the area conducted to subwatershed Bengkawas covered about 3800ha (Ismal, et al 1996)

The Andalas university team is; Dr. Ir. Azwar Rasyidin, M.Agr as the Team Leader. Ir. Gusmini, M.P. Prof. Dr. Ir. Amrizal Saidi ,M.S. Dr. Ir. Erigas Eka Putra, M.S. Dr.Ir. Hermansyah, M.S.,M.Sc. Ir. Irzal. NIP Firmansyah, S.T,M.T. Ir.Yenni.M,M.P. Ir. Elihasridas, M.Si. NIP Ir.

Masrizal, M.S. Ir. Refdinal, M.S. Prof. Dr. Fashbir HM Noer Sidin. Dra. Sri Wahyuni, M.Ed as the member.

The Singkarak lake is located at two district covered the areas 19390ha . Base of the administrative document of the Regional Development Planning (RTRW) district of Tanah Datar covered the areas 6420ha and district of Solok covered about 12970ha. The Singkarak drainage basin conducted 7 subwatershed covered areas about 59300ha that is Imang Gadang, Kuok, Partahunan, Paninggahan, Sumpur, Aripan, Lembang. The degraded land is about 26000ha which 20.000ha was located at the forested land status and 6000ha out of forested land status (Rasyidin 2002).

Since 1973 the areas has been done for many activities both research and action plan for rehabilitate the degraded land that is;

1. Forestry Service Office (Dinas Kehutanan Provinsi) which the name Critical Land Rehabilitation proejct (RLKT) main program is replanting the hilly area which various trees.
2. Agricultural Service Office (Dinas Pertanian Provinsi) which the name of program Conservation farming system at critical land (PPUKLK) which the main crop is the fruit trees.
3. Estate Service Office (Dinas Perkebunan Provinsi) which the nama Coconut for Rural Development program (PRPTE)
4. Rural people empowerment project at critical land under the program Land rehabilition project of critical land (ProLK) funding by West German (GTZ)
5. Research Institution such as, Research center for spices crop, Research Center for staple food, joint research of International Development Center of Japan and Andalas Irrigation studies Center (1997). And also JSPS Unand which Tokyo University of Agriculture (1995-1997)
6. Also action research done by Pusat Pengembangan Masyarakat joint activity ICMI and Directorat General RRL Ministry of Forestry. Which main activity Rural people empowerment for land rehabilitation at Tanjung Alai district of Solok.

Base on the amount of funding and time consume those activities didnot satisfied, there are not optimal results has achived. The size of degraded land not decrease but tend to increase. The main objective that the acitivities didnot solved the water shortage, in other side the rural people participation is low. In order to greening the area needed more rural people participation.

Base on the actual condition Team Sibermas Unand has designed the activities in order to sinergize rural people, university and government district in order to motivate the rural people group for land rehabilitation and agroforestry in order to rehabilitate regional ecosystem at surrounding lake and fresh water ecosystem. The activities is concentrated at the area within the Tanah datar district. At the end our activities is intendeed to promote the Singkarak lake as the region for ecotourism which the integrated between the nature, and cultural heritage. Both of them could be achieved by some modification under the program Rural empowerment of the Singkarak surrounding areas sinergized between Andalas University and local people.

The objective of program for society empowerment.

a. To evaluate the social condition of rural people in relationship with integrated farming system program and land rehabilitation by use agroforestry method and their coordination among the farmer organization at the rural areas.
b. To study the cultural behaviour of the social tradition in their relationship with educational system, skill and knowledge to their comitment for farm management ability and environment sustainability program
c. To empower the rural people group for land rehabilitation using agroforestry system throughout agriculture, forestry and livestock farming.
d. To improve the farmer live standard by using biogass as the subsitution energi for wood and kerosine and promote organic farming to minimized farming depedency to the artificial fertilizer.
e. To improve knowledge and skill of the rural people to promote agroforestry and environmental management in order to promote Tanjuang Mutiara as the center of agro and ecotourism at the Singkarak Basin and surrounding areas.
f. To improve knowledge and skill of rural people to manage the fresh water ecosystem in the relation to the fish population both in the stream and lake system.
g. To established the planning and budgeting for develop rural people at g Singkarak Lake surroundign areas using the agroforestry, integrated farming system, and ecotourism.

Materials and Method

Physical condition of the areas

Kenagarian Guguak Malalo, Kenagarian Padang Laweh dan Kenagarian Batu Taba of the Batipuh Selatan sub distric has selected for society empowerment (Sibermas) program. Those traditional villages are located at the coast of Singkarak lake which the kenagarian Guguk Malalo dan Padang Laweh located in western parts, and Kenagarian Batu Taba in the eastern parts of the Singkarak coast. Those areas in about 38 km from Batusangkar town as the central of Tanah Datar district.

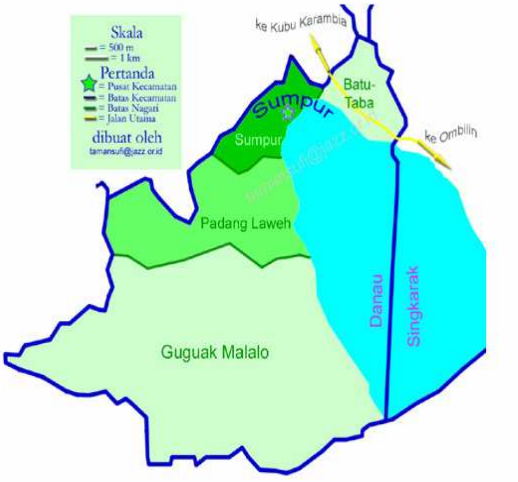
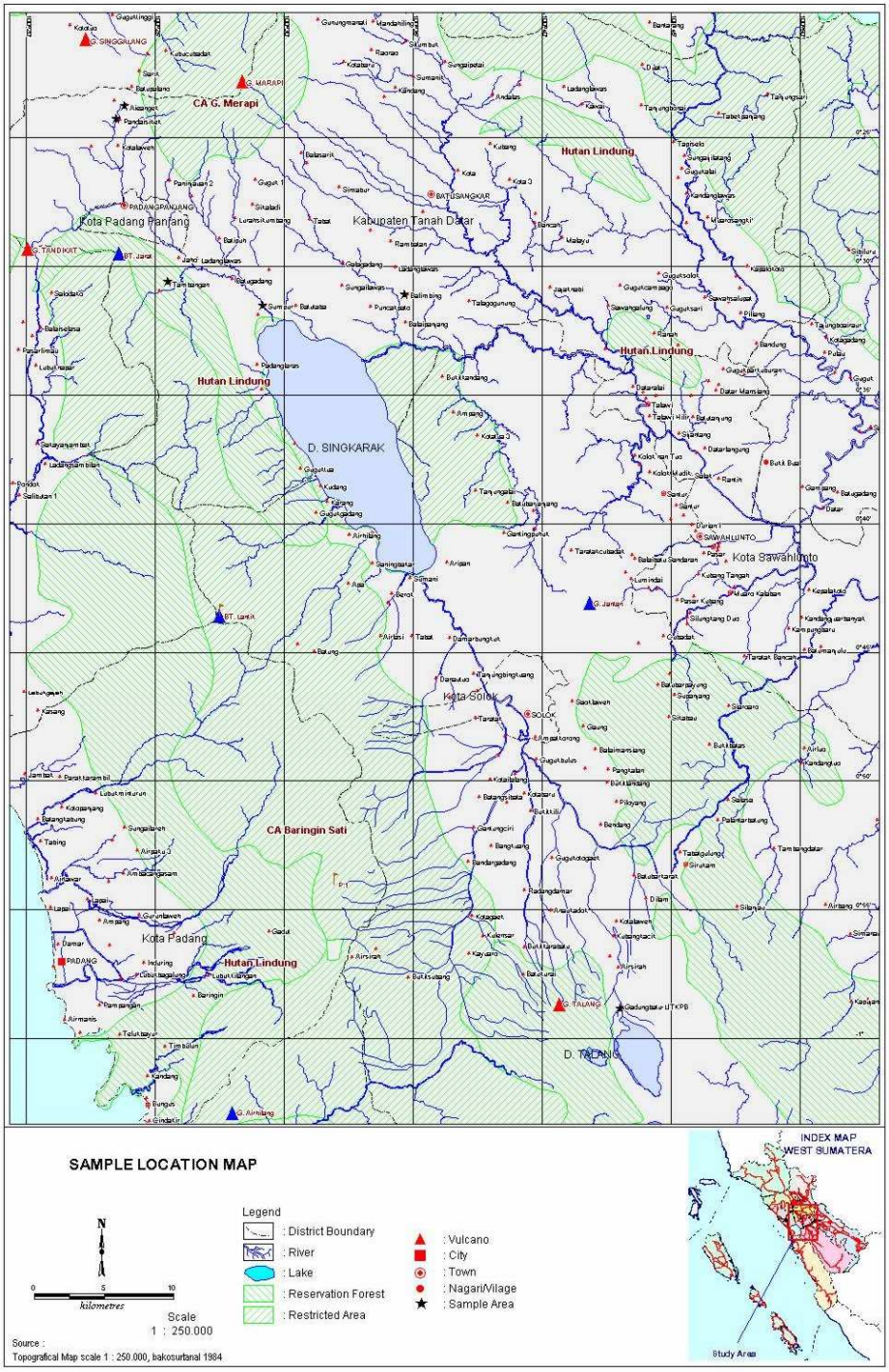


Fig. 1 The map of Batipuh Selatan sub district (Sumber. www. Tanahdarar.go.id)

The land unit in this areas is divided as the lacustrine terraces, hilly , volcanic, and Karst. In the Batu Taba village the land unit are consist of Lacustrine terrace coarse sediment, undulating slope (3-8%) moderaterly dissected (Aq 6.22). Hillocks and Hill in random patern of acidic plutonic rocks, steeps to very steep slope (slope >25%) strongly dissected (Hg 1.3.3) Mountains fine felsic sedimentary rocks, steep to very steep slope (25-75%) strongly dissected (Mf 2.2.3).



Singkarak drainage basin and surrounding areas.

The northern parts ie Sumpur Village consist of Lacustrine terrace coarse sediment, undulating slope (3-8%), Hillocks and Hill in random patern of acidic plutonic rocks. Most of the area is the stratovolcano intermediet tuff and lavas, volcano lower slope and foot slope, flat to sloping slope, (slopes <16%) strongly dissected

Padang laweh village is consist of land unit, Lacustrine terrace coarase sediment (Aq 6.2.2), and volcanic mountains, intermediate tuff and lavas, mountaneous (slope > 16%) strongly dissected.

Guguak malalo consist of Lacustrine terrace coarse sediment (Aq 6.2.2), Karst hard calcareous rocks mountain, steep to very steeps slopes (>25%) strongly dissected in elevation 500- 1285m. Mountain undifferentiate sedimentary rocks steeps to very steeps slope (25-75%), strongly dissected. Geologically the areas could be grouped to the very old geological formation ie Permian geological age, more oldest than Yura formation. In general the areas is unfertile except the area with aluvial and volcan system.

Table 1. The amount of precipitation of the Singkarak Basin from various meteorological station

number of	station	elev	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	sum
station		m	mm												
I	Alahan Panjan	1400	241	193	245	205	192	119	85	139	181	243	262	246	2351
II	Koto Baru	1180	157	155	186	220	127	93	63	108	153	237	270	190	1959
III	Solok	365	250	195	219	220	148	110	74	123	142	215	208	237	2141
IV	Singkarak	365	184	123	158	186	119	72	52	100	148	166	152	205	1665
V	Sumpur	490	190	161	158	180	125	65	56	98	142	175	190	217	1757
VI	Rambatan	575	276	141	216	196	197	62	77	64	116	163	161	186	1855
VII	Batusangkar	460	244	182	203	200	137	113	70	117	148	210	177	215	2016

The Singkarak Basin has various agroclimatical zona, depend on the elevation and distance from the lacustrine coast. The areas along the lacustrin line and the hilly areas is grouping to the E2 Agroclimatological zone of Oldelman, characterized with 2 month consecutive wet zone and three month consecutive dry month. Detail explanation is shown in the table 1. Data from agroclimatological station of Singkarak, Sumpur and Rambatan has annual precipitation in the value 1665mm, 1757mm, and 1855 mm respectively for Singkarak, Sumpur and Rambatan. The mountain area in the surrounding lake is the A agroclimatological zone of Oldelman such as the subdsitrict Batipuh and X Koto in the northern parts with annual precipitation 3110 mm and 4363 mm respectively. Or data from agroclimatological station of Alahan Panjang in the southern parts with annual precipitation 2351 mm. Base on the land unit and amount of precipitation the areas was divided as two parts. The western parts as the wet areas and the eastern parts as the dry one. The western parts area conducted Guguak Malalo and Padang Laweh is

affected by the precipitation from the Batipuh and X Koto subdistrict, while Batu Taba in the eastern parts is affected by Rambatan and Singkarak rainfall pattern.

Method

The program are divided at fourth main activities,ie; previous work, rural apraisal, action plan, reporting and evaluation. At the previous work team has collected all of the information from the library. Based on the discussion results of the desk study team proposed the short term activities planning. To know the detail of the rural potensial, the method of rapid rural appraisal has adopted. Action plan were definite after discussion with the district government office especially with the head of District Agricultural Service Office (DASO). The activities at the site mostly done by the extension method . in this activities the main target is the farmer group or social activities group**.**

Results and discussion

Related to the geomorphological and hidrological pattern acitivities is divided as two ie. The western parts is possible to develope as integrated farming system and ecotourism areas. The area will possible to develope as independence village especially in the rural enersi using the microhidroelectric power or biogass. While in the eastern parts is developed to the center of land rehabilitation using the estate crop and forestry. Jatropa curcas was selected as the crop which high suitability for the areas, as far as the areas have a shalow soil and dry climate.

The program for society empowermen of Singkarak basin is shown in the table 2

Table 2. Subsector and crop priority for society empowerment of Singkarak Basin Under district of Tanah Datar.

no	Subsector	priority
1	Ecoturism	Rice filed, forestry and cultural heritage
2.	Land rehabilitation/agroforestry	Horticultura, /honey bee and cacao smallholder developent
3	Integrated farming	Rice, horticulture, vegetable and fruit trees livestocks farming
4	Livestock farming	Cow , water buffalow, goat/sheep, chieken
5	fishery	Lacustrine fish, river and pond

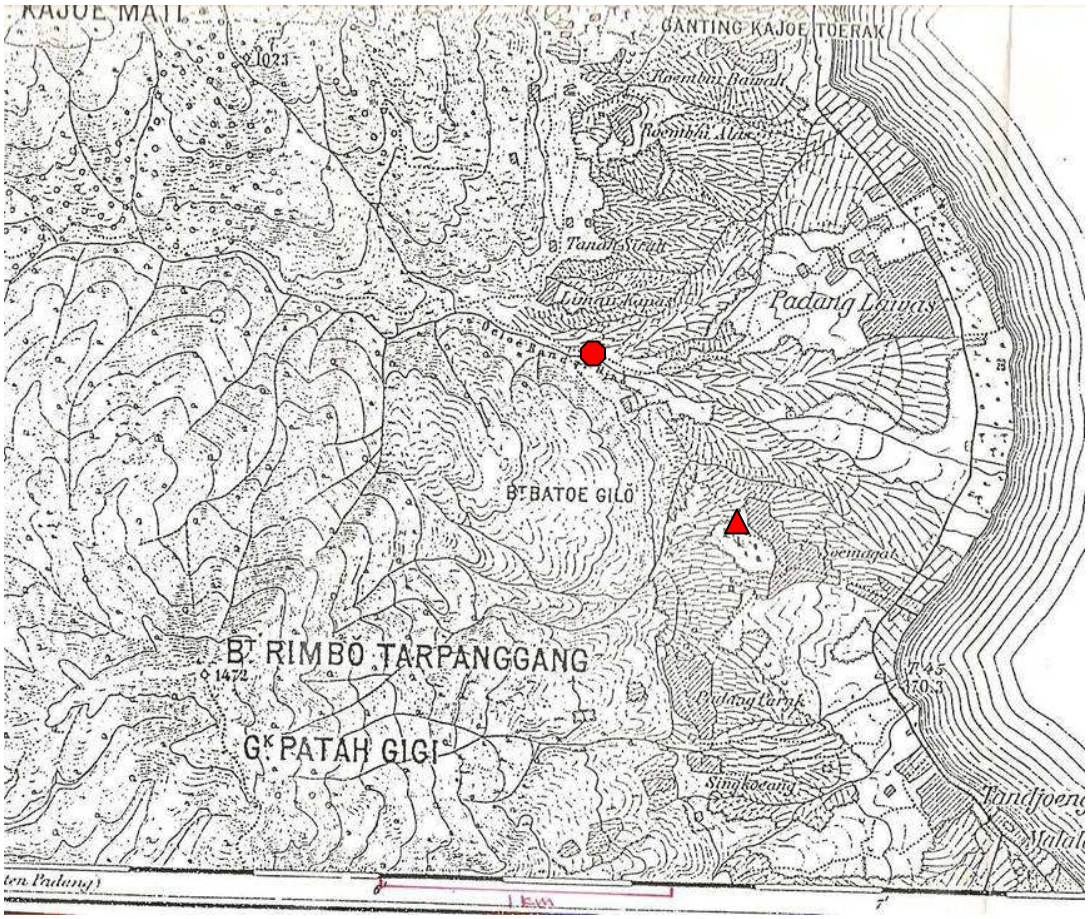
Basic consideration for selected areas;

1. Base on the mission of the Government district of Tanah Datar, one of their mission is to empowerment the village people wellfare by increasing their income with the specific product using the developing economic institution such as

cooperation for promote agroindustry and agroecotourism, especially in the lower village income.

2. The Batipuh Selatan sub district will promote by district governmenr as the center for tourism..
3. The Tanjung Mutiara in Batu Taba Village located in the lacustrine line is grouping for lake and sea tourism program

Activities were conducted social approach district government office, subdistrict and people who lifes at the areas. At the previous planning the activities will be done at fourth subdistrict ie, Sub district Batipuh Selatan, Batipuh, Pariangan and sub dsitrict of Rambatan. Discussion with head of District Agricultural Service Office (DASO) the activities is concentrate at sub district of Batipuh Selatan which conducted three tradisional village (Kenagarian ie, Guguak Malalo, Padang Laweh and Batu Taba)



Explanation = fish pond as agrotourism center

Llocation of BPP Batipuh Selatan office

The map of , integrated farming system, and agrotourism at Padang Laweh

In the first year we selected six farmer and fishermer group (Keltan); farmer and fishermer groups Puncak Pulau, farmer and fishermer groupsTaratak Hulu, farmer group Saiyo, farmer and fishermer group Rawang Talao, farmer and fishermer group Kataping,

and one Social Intitutional for education Al Islam di Batu Taba. In our plan the Yayasan Al Islam will promote as the pionir for land. After one year past the number of farmer and fishermen participant increase more than 2 time (see table 3) including the number of Social Institutional for Education Tuanku Lima Puluh at Guguak Malalo.

The farmer and fishermer group Puncak Pulau and Taratak Hulu has three activities, do the farming system to produce staple food, fishing in the lake Singkarak and their also promote the fresh water pond in the hilly areas for develop fresh water fish. The pond located at the inland areas of Banda Jao stream (see the map)in the areas about 10ha. The funding for activities of two group are supported by H Armaini who the succesfull merchandize and have the intension to promote the rural economic.

The amount of water flow is enough to produce electric power in the value 4000 KVA. The fish pond are located near to the hilly areas where the animal as the fish predator lived there. Those animal movement always in the night, to keep the fish pond out from predator, the area at surrounding pond should be lighted, so is needed electric power. In order to keep out the fish pond from predator one set of microhidro electric power has established here. As far as the farmer almost no experiences for fish pond because they are more familiar for fishing at the lake surface. Ind order to the real condition the farmer and fishermer group needed more guidance to motivate the group .

The problem for develop fish pond program is

a. Feeding
b. Fish breeding
c. Slow growing
d. Marketing
e. Govermenment supporting policy
f. No electrictricity power
g. Technological transformation.

Base on the site problem we setting up extension program. First priority is feeding, training for technological transformation of fish feeding has done conducted by fourth farmer and fishermer group one farmer group and one the Institution education at rural level. The goverment district office supported by prepare one set of fish food processing machine at the end of November 2008. for prepare the fish feeding, so many materials are not available in the site. We tried to promote the alternative material but this rather difficults compare to buy the fish feeding.

Before developed fish pond the group in their activities are the fishing at the lake surface, rural people as the farmer used their time 30% for farming and other for fishing, but now condition already changed . The surrounding lake or near the coastal lake is known as the spesific rural areas which the main livlihood of resident is fishing and farming. The kind of fish in Singkarak lake is Bilih (Mystacoluecus Padangensis BLkr) this kind of fish is originate from Singkarak lake , an others kind of fish are Asang (Osteochilus brachinopterus), Turiek (Cyclocheilichtys spp de Zwani) and sasau (Hampala spp). Since the Singkarak hidroelectric power was operated in 1988 the natural condition of lake ecosystem already changed.

Singkarak basin is the inland areas of Indragiri cathment. At natural condition the surface water level controlled by the flowing to the Ombilin river as the one of branch river of the Indragiri river. The shore line changes is depend to natural fluctuated in

balances between precipitation, evaporation and water flow. Natural water balance has reported by Ismal et all (1996) in their tesis they mention that the water are belance between the input and output which the annual average of run off percentage is 62%. The annual average of water discharge at ombilin 43.9m^3/sec, the data from 1973-1981 shown that debit are fluctuated which the maximum discharge 111.1 m3/sec and minimum discharge 6.9m^3/sec. The discharge value are in the range of run off prediction by Ismal et al in the range 32-66:62)%. Disruption of natural condition was observed since the water outflow to Anai watershed in the value 57.3 m^3/sec in order to produce electric power. Comparing the outflow to electric power with the natural flow to Ombilin river were observed the value minus 13.4 m3/sec or equivalent which the rainfall 5.97mm/day. In order to support the amount of water discharge for electric power the natural condition changed become artificials. In the rainy season water in the Ombilin river closse to increased the water volume in the storage, this cause the water level is higher and in the dry season the water level become lowest. The artificial condition is not favorable for lacustrin ecosystem.

The change in the surface water level of the lake was affected ruinous of some of the lacustrin vegetation. The natural coastal lake vegetation in the local name is *Dalu-dalau* is the kind of mangrove is rather difficult to observed along the shoreline compare to the condition on 1998. Syandri 2008 has reported. Changes in the lacustrin ecosystem also affected the quality and quantity of fihshing yields drastically. In 1998 the size of Bilih in the average 19 cm long, but afte ten year the average 3-6cm

In order to survive the fisher and farmer group was adopted transformational technologi. They want to changes their habit from the fishing to farming by developed fish pond. Two of farmer and fishermer group Taratak Hulu and Puncak Pulau become the pionir to fish pond at the mountaneous and hilly areas. Those group has funded by H Armaini whos the indigeneous people which the main livelihood as the inter island traders.So numerous farmer and fishermer group exist in the Singkarak Basin, and the people such as H Armaini is to limited, frankly speaking the people in the shore line has the great hope to live under beneficient of the lake.

The fish pond of farmer and fishermer group located at hilly and montaenous areas about 650m from sea level. The location has the nice scenery and possible to developed as the place for tourism. In order to developed as the place for agroecotourism the nearest to the fish pond has equipped with another facilities, parking place, restourant and swimming pool. To promote the agroforestry and agrotourism the group already planted the citrus auranti folia as the agroforestry crop.

Saiyo farmer group was selected staple food crop such as as rice and mayze, the farmer and fishermer group Rawang Talao and Ketaping selected the rice, they adopted the method for system rice intensification (SRI) and promote the organic farming. Their product has certified by the West Sumatra Intitute for Organic Certification (LSO). To promote the agricultural system for sustainability especially in energy consume for rice. Integrated farming system is the best way, livestock farming and rice cultivation is promote as the integrated system and also to produce bioenergy from the cow faeces.

Extension program for staple food production especially for transformation technologi SRI joint program between Unand Team and Center for agricultural extension (BPP) subdistrict Batipuh Selatan has done as the Sekolah lapang (Agricultural field school). The program has done 20 time in every one fiscal year or every two weeks. The

number of farmer group increases compare to the fiscal year 2008/2009 with 2009/2010. The name, group leader and the kind of crop selected by the group. Every group usually has 20 person active member.

Table 3. The farmer and fishermer group for stapel food production using the System of Rice Intensification

no	Nama kelompok	Group Leader	crop	kenagarian
1	Muaro Hijau	Bunnyamin	jagung	Batu Taba
2	Sigumandi	Najib	Padi	Batu taba
3	Mutiara	Indra dt batuah	Padi	Batu Taba
4	Sawah baruah	Iswandi	Padi	Sumpur
5	Sawah tangah	Syafrudin	Padi	Sumpur
6	Sawah pudung	Lalen	Padi	Padang Laweh
7	Harapan Maju	Zulkarnaini	Padi	Padang Laweh
8	Rambahan	Zulfahmi	Padi	Padang Laweh
9	Saiyo	Kashmir	Padi	Padang Laweh
10	Sawah Kumpai	Mirwan Jamal	Padi	Padang Laweh
11	Sawah Bancah	Dt Pahlawan	Padi	Padang Laweh
12	Rawang Talao	Junaidi	Padi	Guguak Malalo
13	Banda Tapung	Musfar	Padi	Guguak Malalo
14	Alahan Sabatang	Ridwan	Padi	Guguak Malalo
15	Kandang Gajah	Suherman	Padi	Guguak Malalo
16	Mandiri	Watilis	Padi	Guguak Malalo
17	Lembang Saiyo	Yurnalis	Padi	Guguak Malalo

The western parts of Singkarak basin is wetter than the eastern parts. The village in the western parts such as Guguak Malalo, and Padang Laweh have many stream originated from the mountaineous area. The stream is the good place for fishing the Bilih (Mystacoluecus Padangensis BLkr) by the tradisional ways with the name *Alahan.* The capacity of alahan to get the fish in the range 50-60 liter/days or equals with 70-90 kg/days. With assume that working days 150days/years, each alahan will produce 11.25-13.5 ton/years. Because the area in western parts has many stream the area also has many alahan. The farmer who has no land for alahan they use the gilnet. The yield are fluktuatif, the lower value is 4.5-7.5 ton/ha, but some time is more lowest in about 10-20 kg/days.

Income of the fishermer also fluktuatif, depend on the fishing condition and market condition. The price are depend on the colector, market is tend to monopolistic and the farmer didnot have other alternatifas far as no technology adopted to keep the fish fresh or not become a rotting fish. In order to keep the balance between suplay and dimand simple technology for drying method were promote to the farmer. By using the solar radiation and keep in the box like oven the fish will dry during 3 hours. Dried fish will possibly to keep in the storage or possible to packing and marketing out of the Singkarak basin without rotting. Bilih Singkarak has the specific taste, this is possibly to promote as the mascot toursm of the Singkarak basin by prepare the best packing and grading before.

Conclusion

The program for society empowerment (Sibermas) has done at Sub district of Batipuh Selatan, District of Tanah Datar for two fiscal years. 2008/2009 and 2009/2010. the program has more success in the western parts compare to eastern parts. Geological factor especially the hydrological factor is better in western parts, more wetter and possibly to develop farmer and fishermer group which cultivate staple food crop such as rice and corn. The number increasing of group farmer and fishermer in the western parts is indicate that System of Rice Intensification (SRI) and integrating farming system or organic farming are possible to develop at the western parts compare to eastern part.

The mountaneous and hilly areas in the western parts is forested areas, and there are many small stream originated from there. The existence of stream has strong relationship with the fishing of Bilih (Mystacoluecus Padangensis BLkr) by tradional method (Alahan). The Yield of *alahan* are depend to the amount of water flow from the mountaneous, even the water not so fluctuated the yield is relatively constant.

Base on the historical and sociological factor, the rural people in the shore line of Singkarak basin has the strong dependency to the lake. We proposed for the future the activities of farmer and fishermer group should be focused for fresh water ecosystem, while an other activities were function to support the ecosystem work.

The eastern parts as their located in the Trans Sumatra Highway, and also has the railway. The areas possibly to develop as the location of agro ecotourism and for marketing the fresh water product. However, land rehabilitation program using the trees will possible to solved the water shortage at the mountaneous and hilly areas.

References

Berlage, Jr., 1949; Regenval in Indonesia, Departement van Verkeer, Energie en Mijnwezen, Meteorologisch en Geophysische Dients. Koniklijk Magnetisch en Meteorologisch observatorium te Batavia, Verhandlingen No.37, 210pp.

Burt, T.P. and Butcher, D.P., 1985; Topographic controls of soil moisture distributions, J. of Soil Sci. 36:469-486.

Daras, U dan A.Ruhnayat. 1990 Potensi Sumber Daya Lahan di Sekitar Danau Singkarak Untuk Pengembangan Tanaman Industri dan perkebunan . Dalam Azmi Dhalimi Dkk (ed), 1990, Komunikasi ilmiah Pengembangan Tanaman Industri dan perkebunan pada Lahan Kritis Sekitar Danau Singkarak- Sumatera Barat (Prosiding) Solok 5-6 September 1990.

Drever, D.P,1986. Geochemistry of Natural water, 437pp., Prentice Hall, New York.

Hakim, N, Ismal, G., Mardinus dan Muchtar, H., 1993. Perbaikan lahan kritis dengan rotasi tanaman dalam budidaya lorong, Simposisum Pennelitian Tanaman PanganIII, pusat Penelitian dan Pengembangan tanaman Pangan Bogor 23-25 Agustus 1993.

Ismal, G., Rasyidin, A., Arief,A. and Syahni, R., 1996. Land rehabilitation and development of Upland Ecosystem, A case Study of Singkarak drainage Basin, West Sumatra, Indonesia. Tokyo University Of Agriculture

Kamaludin, R, 1990. Program Pembangunan Wilayah di Sekitar Danau Singkarak, Sumatera Barat. Dalam Azmi Dhalimi dkk (ed), 1990, Komunikasi ilmiah Pengembangan Tanaman Industri dan perkebunan pada Lahan Kritis Sekitar Danau Singkarak- Sumatera Barat (Prosiding) Solok 5-6 September 1990.

Nurdin, F. 1990. Peluang dan peranan Pengembangan Tanaman Perkebunan di Sekitar Danau Singkarak. Dalam Azmi Dhalimi dkk (ed), 1990, Komunikasi ilmiah Pengembangan Tanaman Industri dan perkebunan pada Lahan Kritis Sekitar Danau Singkarak- Sumatera Barat (Prosiding) Solok 5-6 September 1990.

Oldelman,L.R., Irsal Las, and Darwis, S.N., 1979.; An Agroclimatic Map of Sumatra. Contr.Centr.Res. Ins.Agric. No.52, Bogor, 35pp

Rasyidin A, 2002. Pengaruh Manusia Terhadap Degradasi Lahan. Jurnal Penelitian Andalas no 38/Mei/tahun XIV/2002.

Syandri H, 2008. Ancaman terhadap plasma nutfah ikan bilih, Pidato pengukuhan profesor.

Tim Pengkajian sosial ekonomi masyarakat sekitar Kerinci, 1997. Laporan akhir kerja sama Partisipasi ICMI dalam rangka pengkajian sosiial ekonnomi masyarakat sekitar kerinnci, Direktorat jendral Reboisasi dan rehabilitasi lahan Departemen kehutanan RI.

Verstappen, 1973; A Geomorphological Reconnaisance of Sumatra and Adjacent Island (Indonesia), IInst. For Aerial survey and Earth Sci. (ITC), Enschade, Walter noordh off Publishing, Gronigen 182pp.

Beberapa Foto Kegiatan

figure 1. stream water flow from the mountaneous area in the Kenagarian Guguak Malalo

Figure 2. the location of fish pond Taratak hulu and Puncak pulau farmer and fishermer group in about 10 ha located ± 1km from the shoreline of Singkarak at Ulu banda Jao (muaro Samuik) elevation 600m dml

Figure 3. General meeting at Batipuh Selatan sub district office , Oktober 8 2008

Figure 4. from left to ricght . Dr. Ir. Erigas, Dr. Ir. Azwar Rasyidin as team leader, Ir. Arfiah Asistence of economic and welfare of Tanah Datar government district. Basrizal dt Rangkayo Basa as representative of rural people of Batipuh Selatan

Figure 4. Tradional ways for fish drying

Figure 6. Alahan located at Baing of the Kenagarian Guguak Malalo

Figure 7. Drying machine by used the solar radiation from Sibermas Team with capacity 10kg/3 hr