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CASE STUDY OF THE TEXTILES, LEATHER AND WEARING APPAREL SECTOR

Clive Hamilton
Clarita Iskandar

Natural Resources Management Project
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Preface

NRMP-IEA Technological Scenarios

The Natural Resources Management Project (NRMP) assisted by USAID in association with the Institute for Economic Analysis (IEA) at New York University is carrying out a modelling exercise to project the economic, employment and environmental consequences of different development paths for the Indonesian economy. The purpose is to provide advice to the Indonesian National Planning Agency (BAPPENAS) to assist in the development of the next five-year plan (Repelita VI) and the next Long-Term Development Plan. The first stage of this work has already been completed with the support of the Environmental Programming Support Services Project of CIDA.

The analysis, of which the present paper is a component, will provide advice on the trade-offs and complementarities between the growth of income and employment on the one hand, and the levels of natural resource depletion and degradation of the natural environment on the other. For instance, it is important for policy makers to know how the development of the pulp and cement industries over the next 20 years is likely to affect air and water pollution and how costly or cost-saving it will be to adopt cleaner technologies than are being used now.

The analytical framework includes a dynamic input-output model covering all economic activities. The model is dynamic in two senses. First, it incorporates a representation of investment in which levels of sectoral investment depend on expected growth of output, the technology in use and levels of capacity utilisation. Secondly, the model is dynamic in that it explicitly incorporates projections of changes in technology for a range of sectors in the economy, including agricultural sectors, forestry, energy sectors and key manufacturing sectors.

Technological scenarios are developed for each of these sectors using detailed information about likely technological and institutional changes obtained from technical experts. They include expected changes in intermediate inputs, notably energy and raw materials, capital stocks and human resources of different skill types as well as expected changes in natural resource usage and environmental degradation associated with current and alternative future technologies.

This paper is one of a series of working papers prepared by NRMP and IEA researchers in collaboration with industry experts. The papers will form a vital part of the data base for the numerical computations. In addition, they will be valuable as stand-alone analyses of technological futures for a range of important industries in Indonesia.

It should be noted, however, that some of these working papers (especially those on manufacturing sectors) were prepared under severe time limits and should not be taken to represent the last word on technological change in the industries in question.

1 Introduction

The textiles, leather and wearing apparel industry is classified as Sector 17.2 in the NRMP-IEA 30-sector classification (part of the Other Manufacturing sector). It is Sector 36 in the BPS 66-sector classification. It covers several industries including weaving, wearing apparel, knitting, tanned and finished leather, footwear and leather products, and carpets and rugs. The shares of each sub-sector in the 1985 value of output are shown in Table 1.

Table 1. Shares of output in the textile, leather and wearing apparel sector

BPS 169-sector classification		Share of 1985 value of output
76	Weaving	49.7
79	Wearing apparel	25.1
83	Footwear and leather products	7.5
78	Knitting	5.6
80	Carpets, rugs, rope and the like	
77	Made-up textile goods (except (wearing apparel)	3.8
82	Tanned and finished leather	2.2
81	Other textiles	0.9

Source: BPS, *Indonesia Input-Output Table 1985*, Volume 1, 1989

It is apparent from Table 1 that weaving and wearing apparel accounted for a very large share of total output in 1985. In 1990, the weaving subsector still contributed the biggest share in the sector, but wearing apparel had grown more rapidly. According to the BPS Industry Survey (BPS, 1990), the share of weaving had fallen to 45.3 per cent in 1990, wearing apparel had risen to 29.4 per cent, footwear and leather products to 9.5 per cent, and knitting to 8.5 per cent.

The major intermediate inputs for the sector are provided by yarn spinning, textiles, leather and wearing apparel, chemicals and petroleum refining. The principal intermediate inputs for Sector 17.2 are listed in Table 2 and the principal using sectors are listed in Table 3.

Table 2 Intermediate inputs for Sector 17.2

BPS 66-sector classification		Share of total intermediate inputs (%)	Input coefficient
35	Yarn spinning	39.0	0.256
36	Textile, leather & wearing app	26.4	0.193
40	Chemicals	7.9	0.051
41	Petroleum refining	2.0	0.013

Source: BPS, *Indonesia Input-Output Table 1985*, 1989

Table 3 Principal using sectors for Sector 17.2

BPS 66-sector classification		Share of total deliveries (%)
301	Private consumption	43.4
305	Exports	21.2
36	Textiles, leather & wearing app	16.6
55	Other services	4.1
302	Government consumption	1.7

Source: BPS, *Indonesia Input-Output Table 1985*, 1989

In this case study of the textile, leather and wearing apparel sector, we focus on two subsectors, weaving and the tanned and finished leather industry. These two subsectors accounted for 51.9 per cent of the value of output in the sector in 1985. Selection was based on their shares in the total value of output and their environmental impacts.

2 The Weaving Industry

The major stages of production in the weaving industry are weaving, desizing, bleaching, mercerizing, dyeing, and finishing. Fabrics produced in the weaving process are further processed by desizing, dyeing and finishing. The stages of production are:

- singeing -- removal of fluff from the unfinished cloth (grey) surface;
- desizing -- removal of starch from the weaving process, using enzymes or soda ash;
- boiling -- removal of impurities contained in grey;

- bleaching -- removal of colour compound which is left over from the boiling process using caustic soda and hydrogen peroxide;
- mercerizing -- using caustic soda (NaOH) solution, during straining of grey. This process increases the absorptive capacity of colouring compounds and chemicals in the dyeing process and increases the brightness;
- drying -- this process takes place in a heat set machine (with steam) or in a pet dry machine (with infra red); and
- dyeing -- using dyestuffs.

Afterwards, there are two kinds of treatment: dyeing finishing (for plain textiles), including curing and steaming,; and printing and dyeing finishing (for patterned textiles). In dyeing finishing, there are two kinds of treatment: mechanical, using an iron; and chemical, using softener (for softer products) or PVA (for more rough products), and other chemical such as resin finish and sanforize.

Current Technology

The description of current technology is derived from data gathered from PT Argo Pantes, an integrated textile plant, PT Century Textile and PT Sandratex. Argo Pantes produces printed and non-printed fabrics while Century Textile and Sandratex produce only non-printed fabrics.

According to CIC (1992), Argo Pantes and Sandratex are two of the biggest textile plants in Indonesia, each with a capacity of 0.6 per cent of total Indonesian capacity. Century Textile contributes 0.4 per cent of total capacity. Argo Pantes uses the most advanced technology in textile making in Indonesia. According to the plant manager from this company, the technology used in Argo Pantes is almost 10 years ahead of the average textile plant in Indonesia.

The production process in these companies includes weaving, desizing, bleaching, mercerizing, dyeing and finishing. For printed fabrics, before the finishing process, fabrics undergo the printing process.

The difference in technology used in more advanced plants occurs in the machines used in the weaving process and in the chemical recycling process. According to Argo Pantes, currently there are only 10 factories (out of a total of around 1,083 in Indonesia in 1991) which use a chemical recycling process. More advanced plants use air-jet machines as well as shuttles (conventional weaving machines). Of approximately one million weaving

machines in Indonesia, only 10,000 are air-jet machines. Most textile plants in Indonesia therefore do not use air-jet machines and do not recycle chemicals.

In the weaving subsector, there are two industries to focus on for describing the technology, manufacture of weaving except gunny and manufacture of printed textiles.

2.1 Manufacture of weaving except gunny

The principal raw materials used in the weaving process are yarn and starch for sizing. Usually there are four types of starch used in this process, natural starch, PVA (polyvinyl alcohol), acrylic and wax. Amounts used are shown in Table 4. This process requires only a small amount of water to dissolve the starch.

Table 4 Raw materials used in the weaving process for three firms

Raw material	Weighted average input (tonnes/tonne)
Yarn	1.1586
Natural starch	0.0427
Synthetic starch (PVA)	0.0520
Acrylic and wax	0.0216
Production (tonnes/month)	528.48

Note: Conversion factors: 1 yard = 0.9144 metres; 1 kg of sheets textile = 7.44 meter

Source: PT Argo Pantes, PT Century Textile, PT Sandratex, 1993

Fabrics produced from the weaving process are further processed in the dyeing finishing department. This process includes desizing, bleaching, mercerizing, drying, dyeing and finishing. Raw materials used in this process are listed in Table 5 below.

Table 5 Raw materials used in the dyeing finishing for three firms

Raw material	Average input - more advanced (tonnes/tonne)	Average input - less advanced (tonnes/tonne)
Caustic soda (bleaching)	0.0437	0.0437
Hydrogen peroxide	0.0211	0.0303
Caustic soda (mercerising)	0.2104	0.2514
Resin	0.0197	0.0283
Chemical additives	0.0198	0.0285
Caustic soda (steaming)	0.0037	0.0037
Detergent & wet agents	0.0072	0.0104
Dye stuff	0.0130	0.0187
Chemical additives (dyeing)	0.0088	0.0127
Production (tonnes/month)	528.48	

Note: Conversion factors: 1 yard = 0.9144 metres; 1 kg of sheets textile = 7.44 meter
Source: PT Argo Pantes, PT Contury Textile, PT Sandratex, 1993 and NRMP estimates

The technology used in the three selected companies is more advanced than the average textile factory in Indonesia. To describe the technology used in the majority of textile factory, we need to exclude the chemical recycling process and the use of air-jet machines from the technology described above. The estimated raw material composition for the less-advanced majority of textile factories is also shown in Table 5 (with no changes in raw material composition for the weaving process).

Labour requirements were estimated from the three plants. The mean number of person years per tonne of output is 3.70 (Century Textiles, 5.73; Argo Pantes, 4.93; and Sandratex, 2.26).

These companies use some air-jet machines which reduce the number of workers required. According to Argo Pantes, one operator can operate 30 shuttle machines compared to only 16 air-jet machines. However, each air-jet machine can produce approximately 8,000 yards of unfinished cloth per month compared to 2,700 yards for each shuttle, giving a ratio of 1:1.6 tonnes per person year in favour of air-jet machines. The use of air jet machines will reduce the amount of labour required in weaving substantially, from 5.92 tonnes/person year to 3.70.

Energy

Sources of energy for the production process are the state-owned electricity utility (PLN), generators and boilers. Boilers are used to produce steam for the steaming process, and water heaters are used in the washing process. According to Century Textile, the weaving process uses 60-70 per cent of total electricity and 10 per cent of total steam and the dyeing process uses 10-12 per cent of total electricity and 80 per cent of total steam.

Natural gas is used in the singeing, drying and curing processes. In future, it is expected that Argo Pantes will use natural gas for its boiler, because gas produces cleaner air and higher heat efficiency. By using IDO and natural gas, the factory can economise and obtain heat efficiency up to 92 per cent. Using fuel oil it can only obtain around 80 per cent heat efficiency. Air-jet machines consume more energy than shuttle machines. According to Argo Pantes, air-jet machines use 2.5 times the electricity required by shuttles but Sandratex reports that monthly energy consumption by air-jet machines is only 17 per cent higher than shuttle machines.

Table 6 Energy consumption in the weaving process

Type of energy	Consumption per unit output (GJ/t) - advanced	Consumption per unit output (GJ/t) - average
Electricity (PLN)	9.1	10.5
IDO	37.2	37.7
Diesel fuel	64.3	66.1
Residual	13.9	13.9
Natural gas	0.5	0.5
Kerosine	1.9	1.9
LPG	0.6	0.6

Source: PT Argo Pantes, PT Century Textile, PT Sandratex, 1993 and NRMP estimates

2.2 *Manufacture of printed textiles*

The major stages in production of printed textiles are similar to those for weaving other than in the printing process. The stages of production (after the weaving process) are desizing, bleaching, mercerizing, dyeing, printing and finishing. The raw materials used in manufacturing printed textiles are similar to those in weaving.

Energy consumption figures for Argo Pantes are reported in Table 7.

Table 7 Energy consumption in the manufacture of printed textiles (PT Argo Pantes)

Type of energy	Consumption (GJ)	Consumption per unit output (GJ/t)
Electricity (PLN)	4320	43.9
IDO	5495	55.9
Diesel fuel	2294	23.3
Residual	2738	27.8
Natural gas	108	1.1

Source: PT Argo Pantes, 1993

Environmental impacts

The environmental impacts of the weaving industry (including the manufacture of weaving and printed textiles) take the form of air pollution and water effluent. The major environmental problem of the weaving industry is waste water, produced from several stages of production, including desizing (starch and soda ash), boiling and mercerizing (caustic soda, hydrochloric acid and suspended solids), bleaching (chlorine and sodium hypochlorite), dyeing (dye stuff), printing (synthetic starch, detergents and sodium hydrosulphide) and finishing (silicon, dissolved solids, and detergents). Estimates of water pollutants for PT Argo Pantes are presented in Table 8. According to the World Bank (1984), air-borne wastes (mainly particulates) do not present a major problem in the production of textiles.

Table 8 Waste water quality from Argo Pantes, 1993 (mg/l)

Parameter	1	2	3	Standard
BOD	8.73	407.50	287.87	85
COD	21.05	1052.58	743.12	250
Dissolved solids	1052	32700	23205.6	1500
Suspended solids	229	15	79.2	60
Ammonia	0.75	2.03	1.65	0.02
Fluoride	0.73	2.57	2.02	1.50

Note: 1 = waste water after treatment
2 = waste water before treatment
3 = 30 per cent of Column 1 plus 70 per cent of Column 2.
Standard = KLH standards

Source: Sucofindo Analytical Laboratories, 1993

Waste water quality for an average textile factory are estimated in column 3 of Table 8. According to Argo Pantes, almost 80 per cent of textile factories in Indonesia have waste water treatment facilities and 20 per cent do not. However, a wealth of informal evidence suggest that the great majority of textile factories in Indonesia do not treat their waste water, and if they do have waste water treatment facilities they are not always used effectively. Therefore it is estimated that in 1985 the average levels of water pollutants can be represented by a weighted mean of the before and after treatment figures in Table 8, with the weights being 30 per cent of 'after treatment' (column 1) and 70 per cent of 'before treatment' (column 2).

2.3 Future technology in the weaving industry

According to industry experts, the future of the weaving industry will be characterised by more recycling of chemicals and the use of more advanced machinery, especially air-jet machines. The technological changes in the future are likely to include:

- an increase in recycling of caustic soda from 20 to 70 per cent;
- recycling of up to 80 per cent of PVA (starch for sizing process). It is also expected that factories will switch to use of PVA alone without mixing it with natural or other starches. This process will require additional investment in recycling equipment;
- use of more advanced machinery in the finishing process reducing the amount of chemicals used in the finishing process by 10-30 per cent.
- the use of narrower basins in the dyeing process will also save 5-10 per cent of dye stuff used.

It is expected that by 2020 textile mills will not use shuttle machines but only air-jet machines. In addition to working three times faster than shuttle machines air-jet machines produce higher quality grey. However, air-jet machines cannot use yarn with knots, so splicers must be used to produce yarn without knots.

It is also expected that automated machinery will be used more widely including computerisation of colour mixing and design. With these changes the industry will require more highly skilled workers.

The use of heat recovery boilers will be widespread in the industry by 2020. With heat recovery, Argo Pantes expects to reduce IDO consumption substantially. It is also expected that weaving plants will use exhaust gases for cogeneration, increasing the

efficiency of generators to 75 per cent, an increase of 25 per cent. The industry also expects to use more natural gas. Coal will not be used because of storage constraints and because dust from coal effects the quality of the product produced.

Sandratex will install two waste gas boilers and four heat exchanger, involving capital outlay of Rp 200 million for each waste gas boiler and Rp 7 million for each heat exchanger.

According to industry sources, it is expected that by 2020 all textile factories in Indonesia will have waste water treatment facilities, as the government will be much stricter about industrial effluent. The predicted waste water quality from textile factories in year 2020 are reported in Table 9. The numbers in Table 9 are derived from Table 8; expected water quality is taken to be 70 per cent of the 'after treatment' levels of Column 1 in Table 8 and 30 per cent of the 'before treatment' levels of Column 2. Although it is expected that in the year 2020 all factories will operate waste water treatment facilities, it is likely that not all of the water treatment will be as efficient as the figures reported for Argo Pantes suggest.

Table 9 Waste water quality from weaving factories, 2020 (mg/l)

Parameter	1985	2020	Standard
BOD	288	128	85
COD	743	330	250
Dissolved solids	23206	10546	1500
Suspended solids	79.2	165	60
Ammonia	1.65	1	0.02
Fluoride	2.02	1	1.50

Note: Standard = KLH standards
Source: Table 8.

Each of these technological changes will require additional investment, including investment in machinery for recycling PVA, air-jet machines, heat recovery and exhaust gas systems, waste gas boilers and heat exchangers and computerisation. According to industry sources, additional investment will be approximately 35 per cent of the value of fixed asset -- 0.5 per cent for recycling PVA machines, 3.5 per cent for heat recovery and cogeneration, 27.5 per cent for air-jet machines and 3.5 per cent for computerisation.

Table 10 summarises the expected changes in technological and pollution coefficients in the weaving industry.

Table 10 Changes in technological and environmental coefficients in the weaving industry, 1985 to 2020

Input/environmental impact		Percentage change between 1985 and 2020
Intermediate inputs		
15	Chemicals	-70
18	Petroleum refining	-24
19	LNG	+600
20	Electricity	-23
Labour inputs		
Total employment		-20
Capital inputs		
17	Other manufacturing	+35

Environmental impacts	1985 level	Change in 2020 (%)
Water input/output (m^3/t)	46.38	-22
Water output/output (m^3/t)	38.70	-22
BOD (mg/l)	288	-69
COD (mg/l)	743	-69
Dissolved solids (mg/l)	23206	-68
Suspended solids (mg/l)	79	+135

Note: Numbers on the left indicate sector numbers from the NRMP-IEA 30-sector classification.
Source: see text

3. Tanned and Finished Leather Industry

Current Technology

The stages of production in leather tanning are :

- *Liming* Leathers are soaked in solution to remove body furs and to make them thick, so that they can more easily absorb chemicals. This process uses lime, sodium chloride and sodium nitrate;

- *Flashing* In this process fats are removed from leather by grazing them over a rotating blade and washing them with water;

- *Pickling*: The purpose of this process is to make the leather more cooked producing white leathers. Chemicals used are lime, HCl, acetic acid, sodium bicarbonate and hyposulfide;

- *Bleaching*: This process consists of the wet blue process and the formalin process. Wet blue is used to obtain dark coloured leather, while formalin is used to obtain bright coloured leather. Both processes use HCl, acetate, sodium bicarbonate and hyposulfide;

- *Retanning*: This is the finishing process of leather tanneries in which leathers are soaked in a solution of dyestuff, fat liquor, acetic acid, sodium and alum.

After these steps, leathers are dried and stretched then folded and pressed.

Information on current technologies and likely future changes has been obtained from the firms Tjakung Leather and Pan Vici. They are representative of the industry overall and use processes that have not changed in recent years and are unlikely to change in the next few years.

The tanneries of these firms draw their energy from the state-owned electricity utility, PLN.

According to UNIDO (1990), there are two major sources of waste from leather tanning activities:

- Constituents of raw hides or skins which are removed or modified during the tanning process, including the hair or wool (whole, pulped or completely broken down and dissolved), various collagenous and non-collagenous proteins, natural fats, trimmings, splits and shavings; and

- Surplus and residual chemicals from the tanning process. These wastes can be present in the form of liquid, solid or gaseous discharges.

Furthermore, UNIDO (1990) says that the quantity and quality of liquid discharges generated from the tanning process depend directly on its water consumption. There are several substances contained in waste water from leather tanneries:

Protein and other organic chemicals, such as synthetic tanning materials, oil and greases and organic chemicals. These chemicals increase the level of BOD and

COD in water effluent. Nevertheless these organic substances are biologically degradable, so in practice the waste problem is not severe; and

Inorganic substances, such as chromium, sulphides, chlorides, sulphates and solids (lime).

Currently, Tjakung Leather uses ground water. The system of waste water treatment uses three basins, the first for neutralisation using limestone, the second for screening and the third as water reservoir before discharging into the river.

The first column of Table 11 contains estimates of current levels of waste water quality from leather tanning factories in Indonesia.

Table 11 Waste water quality from leather tanning, (mg/l)

Parameter	Current	2020	Standard
BOD	1300	650	150
COD	3500	1750	175
Suspended solids	3300	1650	150
Sulphide	160	80	1
Total nitrogen	220	110	-
Ammonia nitrogen	65	32.5	0.02
Chrome	100	3	2
Chloride	3500	1750	-
Sulphate	900	450	-

Note: Standard = KLH standards

Source: UNIDO (1990)

3.1 Future leather tanning technology

According to industry sources, there will not be major technological changes in the leather tanning process in the foreseeable future. The major changes are likely to be designed to reduce environmental impacts. One of the predicted changes is the reduction in chrome used in the tanning process to only five per cent of the current consumption. Chrome will be replaced by Bascal-S which does not have a hazardous impact on the environment. Consumption of chemicals per unit of production is not expected to change significantly in the future.

With computerisation, the industry is expected to reduce elementary educated labour by 50 per cent and increase senior high school educated labour by 20 per cent. It is also predicted that they will reduce labour in toggling and other activity by 40 per cent.

The industry expects to reduce energy consumption (electricity) by 30 per cent in future by increasing machine efficiency.

Computerisation will require additional investment. It is predicted that to installation of computerised systems will add 1 per cent to current total fixed capital.

It is also likely that chemical effluents will decrease as more factories operate waste water treatment and the efficiency of waste water treatment increases. The chemical compounds in waste water are expected to decrease by around 50 per cent by the year 2020, except for chrome which will fall by 97 per cent. Although chemical effluents will fall by 50 per cent, they will still exceed KLH standards. Expected waste water quality measure for the year 2020 are shown in the second column of Table 11.

Table 12 summarises the expected changes in technological and pollution coefficients in the leather tanning industry.

Table 12 Changes in technological and environmental coefficients in the leather tanning industry, 1985 to 2020

Input/environmental impact	Percentage change between 1985 and 2020
Intermediate inputs	
15 Chemicals	0
20 Electricity	-30
Labour inputs	
Total employment	-20
Capital inputs	
17 Other manufacturing	+1

Environmental impacts	1985 level	Change in 2020 (%)
Water input/output (m^3/t)	21.83	0
Water output/output (m^3/t)	21.83	0
BOD (mg/l)	1300	-50
COD (mg/l)	3500	-50
Dissolved solids (mg/l)	-	-
Suspended solids (mg/l)	3300	-50
Chrome (mg/l)	100	-97

Note: Numbers on the left indicate sector numbers from the NRMP-IEA 30-sector classification.
Source: see text

4 The Textile, Leather and Wearing Apparel Sector

Within Sector 17.2 (Textiles, leather and wearing apparel), the other major subsectors not yet covered in this paper are (with shares of 1985 total value shown in parentheses) wearing apparel (25 per cent) and knitting (6 per cent). Currently, wearing apparel is the fastest growing subsector. By the year 2020, the share of wearing apparel is expected to rise to 45 per cent of the sector's total output value and weaving will take up 20 per cent of the sector, a decrease of 15 per cent from its 1985 share. In other words, wearing apparel is expected to continue to grow faster than weaving. Wearing apparel also has a higher unit value.

To assess technological change in the sector as a whole we need at least some approximate assessment of expected changes in the wearing apparel subsector. After informal discussions with industry experts in the wearing apparel industry, it is expected that there will be some technological changes associated with energy saving, labour saving and automation.

Wearing apparel is a labour intensive industry. In absolute terms, it employs five times more labour than the weaving industry despite the fact that the weaving industry occupies a larger share of the value of output. With automation, it is expected that the amount of labour used per unit of output in the wearing apparel industry will decline by 20 per cent by 2020.

Electricity is the main form of energy used in the wearing apparel industry. It is expected that energy consumption for lighting will fall by 5 per cent due to improved efficiency. Lighting contributes around 30 per cent of total electric energy consumption, so that energy saving in this subsector will be around 2 per cent.

Technology in the knitting industry is very much like in weaving industry and changes in technology will be similar.

Using the shares of the weaving subsector and the wearing apparel subsector in 1985, we estimate the input changes for the whole of Sector 17.2. In 1985, the share of weaving was 45 per cent and wearing apparel 35 per cent of the total value of output.

Energy savings are expected to reduce electricity consumption by 23 per cent in the weaving industry, 30 per cent in the leather industry and 2 per cent in the wearing apparel industry. With predicted shares of output in 2020, including share of tanned and finished leather 2 per cent, the reduction of electricity consumption for the whole sector is estimated to be 16 per cent. In the year 2020, the predicted chemical input coefficient for the whole sector is expected to fall by around 28 per cent.

Expected reductions in labour inputs per unit output for 2020 for the weaving, tanned and finished leather, and wearing apparel sectors are 20 per cent. For the whole sector, it is thus expected that the labour input coefficient will decline by 20 per cent.

The additional capital requirements per unit output due to changes in technology will vary among subsectors. The weaving subsector will require 35 per cent additional capital per unit output, tanned and finished leather 1 per cent and wearing apparel 15 per cent. The weighted average for the whole sector is 19.2 per cent.

Table 13 summarises the expected changes in technological and pollution coefficients for the textiles, leather and wearing apparel sector as a whole (Sector 17.2).

Table 13 Changes in technological and environmental coefficients for the textiles, leather and wearing apparel sector (Sector 17.2), 1985 to 2020

Input/environmental impact	Percentage change between 1985 and 2020
Intermediate inputs	
15 Chemicals	-28
18 Petroleum refining	-9
19 LNG	+210
20 Electricity	-16
Labour inputs	
Total employment	-20
Capital inputs	
17 Other manufacturing	+19

Environmental impacts	1985 level	Change in 2020 (%)
Water input/output (m^3/t)	46.38	-22
Water output/output (m^3/t)	38.70	-22
BOD (mg/l)	288	-69
COD (mg/l)	743	-69
Dissolved solids (mg/l)	23206	-68
Suspended solids (mg/l)	79	+135

Note: Numbers on the left indicate sector numbers from the NRMP-IEA 30-sector classification.
Source: see text

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